Giant Anaconda
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Master Ramachandra
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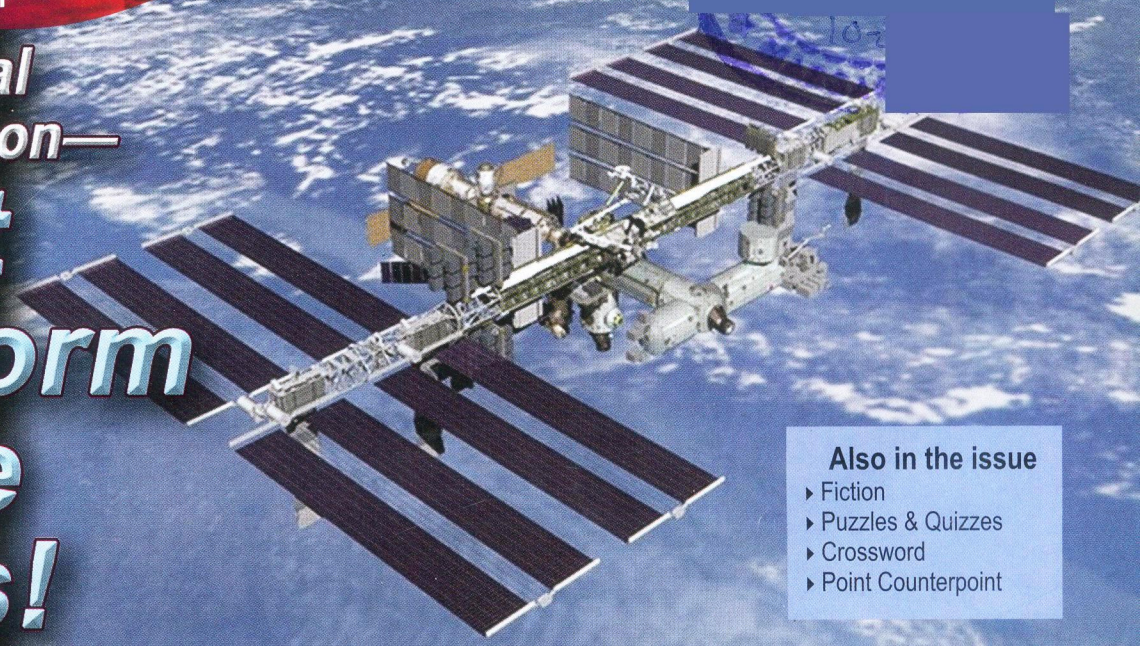
May 2014

Science Reporter

A CSIR Publication

Space & Astronomy Special

International Space Station— Giant Platform in the Skies!



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- Fiction
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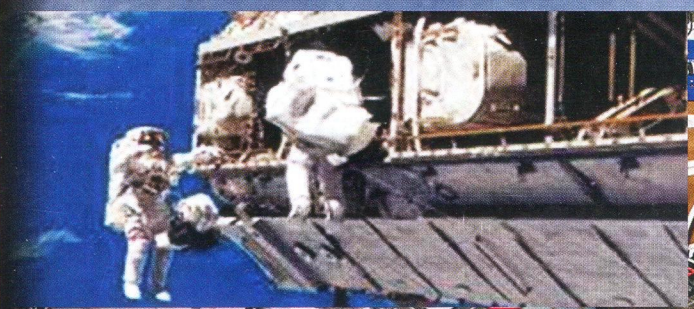
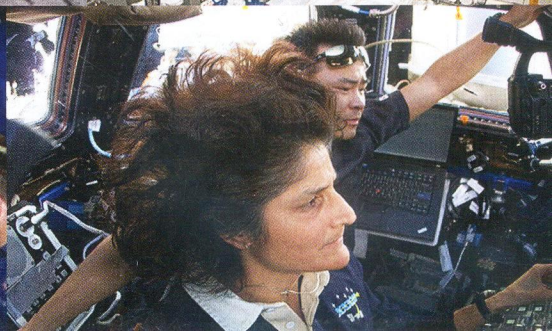
- Creating an Artificial Star
- Lagrange Points
- Fortuitous Changes from Meteor Crashes
- Enigmatic Universe





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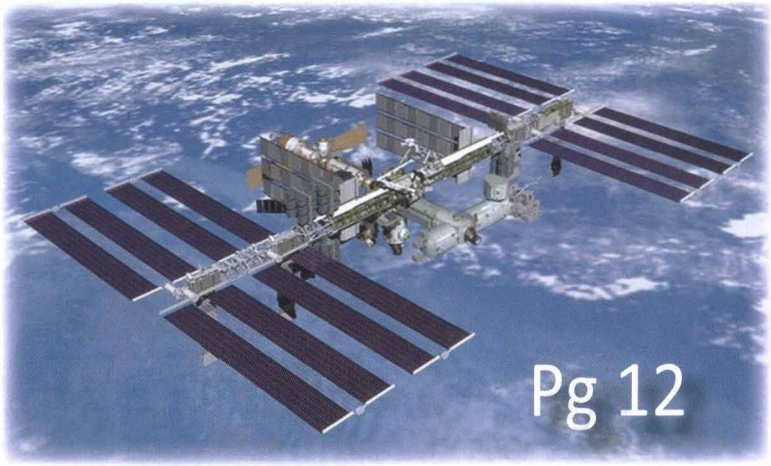

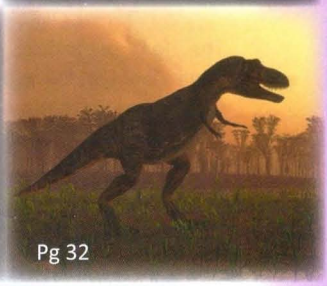

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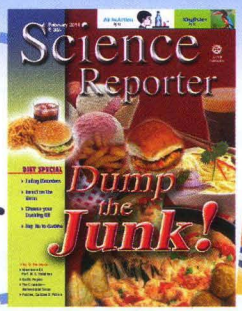
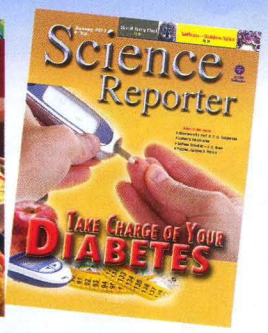




Super Saffron

The article on Saffron by Mohammad Arif Dar published in the January issue was simply outstanding. It is pertinent to say that I have not come across such an elaborate and informative article on saffron earlier.

Saffron obviously is the world's most expensive spice that can be compared with platinum. We are grateful to the writer as he has specifically narrated how to prove the purity of Saffron. I believe, saffron cultivation should be enhanced for the sake of national interest.

Debasis Ghosh, Barraakpur

Realizing the Folly

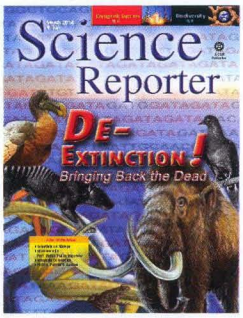
The feature article, **Choose your Cooking Oil with Care**, caught my attention to the point that, 'Whatever I'm eating; is it right'? But this definitive article can have a profound impact in the longer run of life.

Research shows that consuming the right cooking oil/medium can make us live nearly four years more than others. Scientifically, we are aware that "trans fat" and "saturated fats" are the worst offenders. When I conducted a small survey, I interestingly found that most food items that we now-a-days eat contain a large amount of saturated fats. From biscuits, some sort of chips to even hamburgers, we are surrounded by these threatening elements. Therefore, choosing the right oil and eating right food accompanied with salads, fruits and veggies is better than oily foodstuffs like namkeen etc.

Gaurav Tanti, Class-VII,
St. Xavier's School, Bardhaman

De-Extinction: Not an Act of Supernaturalism

It is essential for human beings to pay more attention to conservation of natural



resources and effects on ecosystem rather than on ethical and moral issues as published in the March 2014 cover story **(De-extinction: Resurrecting Lost Species)**.

Humans have no sense of ecological balance. Otherwise, why would extinctions take place? We should focus on resurrecting animals excluding US! Because human beings don't contribute towards nature while other animals do!

Indrani Biswas
Kolkata

The Cryo Saga

In the feature article **India's Firm Strides in Space** (March 2014) Piyush Pandey has done a good job in giving a brief account of India's progress in the field of cryogenic engine technology. Perhaps the author should have referred to the two decades old espionage case in which two key ISRO scientists were alleged to have been honey-trapped by two Maldivian ladies. The episode was embarrassing to all concerned and was to prove detrimental to the space programme.

It may be mentioned that a rocket engine uses either solid propellants (for short range missiles) or liquid propellants (for powering long range missiles and space vehicles). Surprisingly, Specific Impulse (SI), an important characteristic of the rocket engine, was not mentioned at all. For solid propellants it varies from 250 to 300 seconds and 350 to 450 for liquid ones. The liquid propellant used in the all-important third and upper stage of GSLV-D5, which launched GSAT-14 in geostationary orbit, had indigenous cryogenic propellant with liquid hydrogen as the fuel and liquid oxygen as the oxidizer.

Besides the conventional rocket engines, using solid or liquid propellants, there are nuclear rocket engines, in the developmental stage, capable of producing SI as high as 2,500 seconds. American and Russian scientists are researching on electric rocket engines with SI up to 10,000 seconds. The hypothetical photon rocket engine (quantum or laser engine) has the highest possible SI, since the velocity of flow of photons is that of the speed of light.

Dr. S.K. Gurtu, Jaipur

Impressions about Prof. ECG

This is with reference to the interview with Prof. E.C.G. Sudarshan by G.K. Rajesh (January 2014)

As a young aspirant in scientific research, I met Prof E.C.G. Sudarshan in the yea 1988, when after watching an interview of Prof. E.C.G. on Chennai DD channel, I travelled to the Institute of Mathematical Sciences in Chennai of which he was the director.

Immediately on meeting me, he enquired about my journey, and then immediately gave me his Director's pass and asked me to take breakfast at the Institute canteen. Then he spent more than 45 minutes with me. Noticing my difficulty in English conversation, he switched to my regional language Tamil. I was stunned by these two magnanimous acts of the professor.

About research he told me, "Stretch a map, study the whole area and then come to the particular area." His excellent advice was not only helpful to my personal research in seismology but also very useful for my professional NDT field to attain the highest international certification ASNT NDT Level III.

Talking about his experiences with Dr. C.V. Raman, Prof. ECG said that one fine morning when he entered into Dr. Raman's room, he plucked a rose petal from his table vase and asked what it is? It is a rose petal, sir. What is its colour? It is red in colour, sir. Why it is red in colour? Because of pigment, sir. What pigment? I do not know, sir. To which Dr. Raman said, "Sudarshan you do not say, I do not know. You take this petal, study it under the microscope and come and tell me what it is."

S. Prakash,
SQS Institute of NDT, Tamilnadu

HAVE YOUR SAY

If you feel strongly about any article or write-up published in Science Reporter or have some information to share with the readers, please write to us at the postal address given in the magazine or send an Email at sr@niscair.res.in.

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A Step Closer to an Indian GPS!

With the launch of the IRNSS-1B satellite on 4 April 2014, India inched a step closer to realising its very own global positioning system (GPS). The dream of an indigenous GPS is likely to be realised in 2016 when the seventh satellite of the IRNSS series is safely ensconced in orbit.

Although GPS currently covers the Indian subcontinent, as it does the rest of the world, IRNSS will provide exclusive control to Indian space authorities over 1500 kilometres of the Indian mainland. Once in place, the Indian GPS will free the country from any dependence on foreign government controlled global navigation satellite systems, access to which is not guaranteed in hostile situations. India has already had to bear with such an experience in the recent past.

In 1999, when Pakistani troops intruded into Indian territory in Kargil, the Indian military sought GPS data for the region from the space-based navigation system maintained by the US government. However, the US denied it to India. The Kargil experience made the nation realise the inevitability of having its very own GPS.

Many of us have been using the American GPS on smart phones for navigation. But much beyond that, a GPS is necessary also in times of war since most modern precision bombs and missiles depend on accurate positioning. Besides, it is not too hard to realise that in times of crisis foreign government controlled global navigation satellite systems could be switched off lending a crucial blow to critical services and businesses in the country.

In less than two years India will be free from this fear of arm twisting when the Indian Regional Navigation Satellite System (IRNSS) is in place helping the country keep a close watch of not just its boundaries, but up to 1500 km beyond that. The IRNSS comprises a network of seven satellites – three in geosynchronous orbits and the other four in inclined geosynchronous orbits. Once these seven satellites hold hands in space they will 'watch' the entire Indian region from different angles.

While IRNSS-1A, the first in the series, was launched last July, the most recent to go up was the second satellite, IRNSS-1B. In 2014, two more navigational satellites – IRNSS-1C and IRNSS-1D – would be launched. Three more navigational satellites will be launched early 2015 and by middle of 2015, India will have the full navigational satellite system in place. According to ISRO Chairman K. Radhakrishnan, the Indian GPS will be functional by the beginning of 2016.

The IRNSS would provide two services. The Standard Positioning Service would be open for civilian use with an accuracy of 20 m, while the Restricted Service would be encrypted for military use, and which would be able to detect movement of objects less than 10 m. Apart from navigation, the system will help in precise time keeping, disaster management, fleet management and mapping.

Once the Indian GPS is up and running, India will become the sixth country in the world, after America, Russia, Europe, China and Japan to have this system.

Hasan Jawaid Khan

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ZEBRA STRIPES COMBAT BITING FLIES?

HAVE biting flies led to the evolution of black and white stripes on zebras? A research team led by the University of California, Davis, seems to believe so and has published its findings in the April 1 issue of the online journal *Nature Communications.*

The scientists found that biting flies, including horseflies and tsetse flies, are the evolutionary driver for zebra's stripes. Experimental work had previously shown that such flies tend to avoid black-and-white striped surfaces, but many other hypotheses for zebra stripes have been proposed since Alfred Russel Wallace and Charles Darwin debated the problem 120 years ago.

These include:

1. A form of camouflage
2. Disrupting predatory attack by visually confusing carnivores
3. A mechanism of heat management
4. Having a social function
5. Avoiding ectoparasite attack, such as from biting flies

The team mapped the geographic distributions of the seven different species of zebras, horses and asses, and of their subspecies, noting the thickness, locations, and intensity of their stripes on several parts of their bodies. Their next step was to compare these animals' geographic ranges with different variables, including woodland areas, ranges of large predators, temperature, and the geographic distribution of glossinid (tsetse flies) and tabanid (horseflies) biting flies. They then examined where the striped animals and these variables overlapped.

After analyzing the five hypotheses, the scientists ruled out all but one: avoiding blood-sucking flies.

"Again and again, there was greater striping on areas of the body in those parts of the world where there was more annoyance from biting flies," said lead author Tim Caro, a UC Davis professor of wildlife biology.

While the distribution of tsetse flies in Africa is well known, the researchers did not have maps of tabanids (horseflies, deer flies). Instead, they mapped locations of the best breeding conditions for tabanids, creating an environmental proxy for their distributions. They found that striping is highly associated with several consecutive months of ideal conditions for tabanid reproduction.

Why would zebras evolve to have stripes whereas other hooved mammals did not? The study found that, unlike other African hooved mammals living in the same areas as zebras, zebra hair is shorter than the mouthpart length of biting flies, so zebras may be particularly susceptible to annoyance by biting flies.

But why do biting flies avoid striped surfaces? Time for more research?

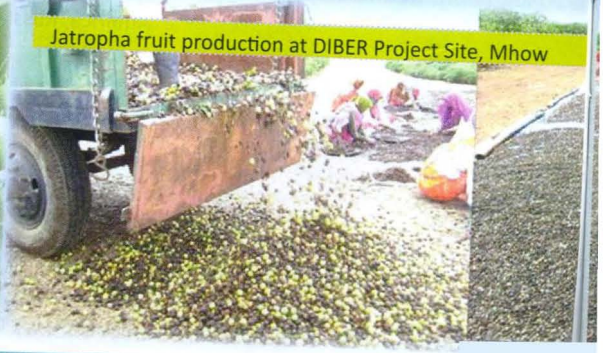
(Courtesy: www.sciencedaily.com)

MODEL BIOFUEL PARK

A model Biofuel Park with 116300 *Jatropha* curcas plants has been established at the Defence Institute of Bio-Energy Research (DIBER), a constituent Institute of the Defence Research & Development Organisation (DRDO) at the Harsola (100 hectare) Military Farm, Mhow. The park was set up in 2007 as part of R&D activities under the DRDO-Army Bio-diesel Programme.

The *Jatropha curcas* plant starts full fruit and seed production after five year of plantation. The Biofuel Park started yielding good fruit and seed yield from 2012. During the last year good fruit yield (13.41 tons of fresh Jatropha fruits) was recorded. This production will increase in the years to come and DIBER will be able to produce more bio-diesel out of Jatropha seeds which will be useful in conducting trials in Defence vehicles. Various trials are being conducted to enhance

Diber Biofuel Park at DIBER Project Site, Military Farm, Mhow



Jatropha fruit production at DIBER Project Site, Mhow

CUTANEOUS LEISHMANIASIS IN RAMPUR BUSHAHR: LACK OF AWARENESS COULD BE DANGEROUS

In India, Cutaneous leishmaniasis is endemic in Himachal Pradesh including Rampur Bushahr in Shimla district, some parts of Kinnaur district and Nirmand and in some places in the Thar Desert of Rajasthan, bordering Pakistan.

LEISHMANIASIS is one of the most diverse and complex of all vector-borne diseases causing significant morbidity and mortality in Africa, Asia and Latin America. It is caused by an intracellular protozoan parasite of genus Leishmania. The disease is endemic in 88 countries in five continents with a total of 350 million people at risk and annually 12 million cases are reported.

The parasite is transmitted by the bite of infected female sandflies, which breed in organic wastes such as faeces, manure, rodent burrows, leaf litter and in dark corners in the crevices of walls having high humidity and temperature. Because of their small dimensions, they can get through standard mosquito nets.

Leishmaniasis is found in three clinical forms: Cutaneous leishmaniasis often involves only the skin, and may be characterized by one to dozens of lesions; Mucocutaneous leishmaniasis involves extensive disfiguring of the nasal septum, lips, and palate, and Visceral leishmaniasis, also known as kala azar, is characterized by the malfunction of liver, spleen and bone marrow.

Cutaneous leishmaniasis is usually painless unless the lesions become secondarily infected, and except in the ear, the ulcers tend to remain confined to the skin and do not affect the subcutaneous tissues. Most skin lesions heal spontaneously; however, the speed of healing varies with the species of Leishmania. In some cases, it may take several months to a year or longer. Some forms leave permanent scars.

In India, Cutaneous leishmaniasis is endemic in Himachal Pradesh including Rampur Bushahr in Shimla district, some parts of Kinnaur district and Nirmand and in some places in the Thar Desert of Rajasthan, bordering Pakistan.

In Himachal Pradesh there are only two hospitals that provide effective treatment of Cutaneous leishmaniasis, one of which is very far i.e., around 120 km from the area where it is endemic. The Mahatma Gandhi Medical Services Complex, Khaneri, Rampur Bushahr, district Shimla is the only hospital in this area where successful treatment is provided to patients. Around 200 to 300 cases of Cutaneous leishmaniasis are treated each year in this hospital free of cost under the National Vector Borne Disease Control Programme.

Recent molecular studies have shown that the causative agent of cutaneous leishmaniasis in this area is Leishmania donovani which usually causes visceral leishmaniasis in humans. Although there are hundreds of cases reported each year, residents of Rampur Bushahr and the neighbouring areas are not aware of the disease. Most people consider it a normal wound or injury. Some patients suffering from Cutaneous leishmaniasis had been visiting private clinics and applying ointments on the lesions. Some were taking antibiotics prescribed by doctors in the local dispensary.

In September 2013 efforts were made to make people aware through posters in Hindi explaining the causes, symptoms and cure of Cutaneous leishmaniasis. There is also need for sustained campaigns or seminars in local schools and colleges of Rampur Bushahr to make students aware of this disease who can then transmit this information to others.

Contributed by Arushdeep Sidana, Ph.D. Student, Molecular and Immuno-parasitology Laboratory, Shoolini University, Solan, H.P.; Email:

the fruit and seed yield of Jatropha in the Biofuel Park.

For maximum utilization of the land of the Biofuel Park, Camelina sativa, another high oil yielding crop, is being grown as intercropping in Jatropha plantation during winters when the Jatropha plants shed leaves and the plant remains naked and hence will not hinder sunlight penetration and crop production.

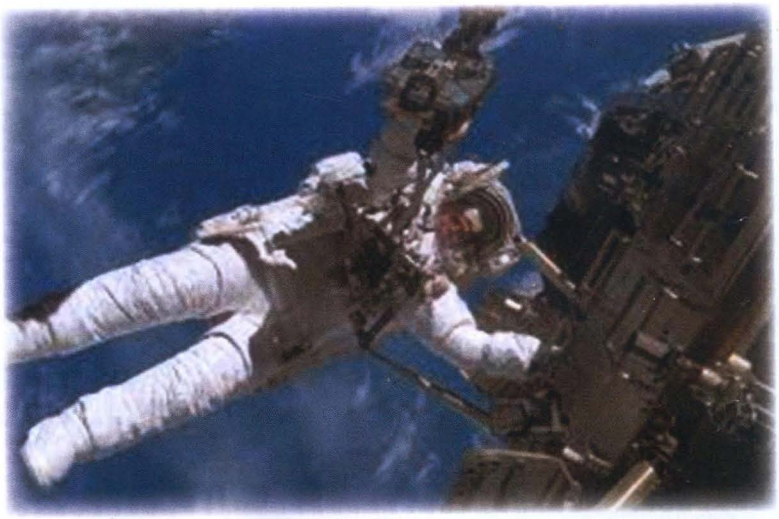
Camelina as intercrop in Jatropha plantation

Contributed by Dr Ranjit Singh, Scientist, Defence Institute of Bio-Energy Research (DIBER) Project Site, Mhow (MP)-453441, Email: sangwanranjit@rediffmail.com; Shri Umesh Singh Scientist, DIBER Project Site, Mhow, and Dr Mohd. Naseem, Director, DIBER, Haldwani (UK)-263139

ASTRONAUTS' HEARTS TURN SPHERICAL IN SPACE

A study of 12 astronauts, presented at the American College of Cardiology's 63rd Annual Scientific Session, shows the heart becomes more spherical when exposed to long periods of microgravity in space, a change that could lead to cardiac problems.

With implications for an eventual manned mission to Mars, the findings represent an important step toward understanding how a spaceflight of 18 months or more could affect astronauts' heart health.



"The heart doesn't work as hard in space, which can cause a loss of muscle mass," said James Thomas, M.D., Moore Chair of Cardiovascular Imaging and Lead Scientist for Ultrasound at NASA, and senior author of the study. "That can have serious consequences after the return to Earth, so we're looking into whether there are measures that can be taken to prevent or counteract that loss."

The researchers say that knowing the amount and type of exercise astronauts need to perform to keep the heart healthy is going to be very important to guarantee their safety on a long flight like a mission to Mars. Thomas adds that exercise regimens developed for astronauts could also be used to help maintain heart health in people on Earth who have severe physical limitations, such as people on extended bed rest or those with heart failure.

The research team trained astronauts to take images of their hearts using ultrasound machines installed on the International Space Station. Twelve astronauts participated, providing data on heart shape before, during and after spaceflight.

The results show the heart in space becomes more spherical by a factor of 9.4 percent. The astronauts' more spherical heart shape appears to be temporary, with the heart returning to its normal elongated shape shortly after the return to Earth. The more spherical shape experienced in space may mean the heart is performing less efficiently, although the long-term health effects of the shape change are not known.

Spaceflight is known to cause a variety of cardiac effects. Upon return to Earth, astronauts commonly become lightheaded or pass out in a condition known as orthostatic hypotension, in which the body experiences a sudden drop in blood pressure when standing up. Arrhythmias have also been observed during space travel, and there is concern that the radiation astronauts are exposed to in space may accelerate atherosclerosis. The research team is continuing to examine these and other potential cardiovascular effects.

(Courtesy: www.sciencedaily.com)

DISPOSABLE PAPER CUPS – THREAT TO HONEY BEES IN SOUTHERN INDIA

POLLINATING insects play an important role in forest and agro ecosystem. Ironically, in recent decades nectarivorous bees are declining at an alarming rate and, surprisingly, in parts of south India, it has been observed that one of the reasons is due to abandoned disposable cups.

Chandrasekaran et al. (2011) reported that increased awareness about environment phased out glass cups and other metal cups from tea and coffee stalls in several areas of Tamilnadu. The usage of disposable paper cups in coffee/tea shops and juice stalls in urban, semi-urban, rural and eco-tourism spots and protected areas in Tamilnadu, is common now.

Remnants of sugary residue in the abandoned cups attract the honey bees. Instead of visiting natural flowers, the bees find an alternative food source in these cups. However, these cups act as 'death traps' for them because they fall into the cups and are unable to come out and fly, which results in large-scale mortality. The researchers reported the death of nearly 168 bees every day from a single shop and reported 25,211 dead bees in the coffee bars in their study area within 30 days.

We have also found that the dammar bees or stingless bee, *Melipona iridipennis* (Meliporidae), an important pollinator, also get attracted by disposable cups. Within ten minutes of our observation we found nearly 48 bees lost their lives in a single cup – we found more than 800 bees in a single dust bin placed before a tea shop on the same day (8-hour observation). If the trend continues for a few days or weeks the workers in the entire colony will lose their lives.

The honey and wax produced by the dammar bees play an important role in the livelihood of the poor forest-dwelling communities in the Nilgiri Biosphere Reserve (NBR) where 15 local ethnic groups harvest honey as a source of revenue (Keystone Foundation 2001).

Loss of nectarivore bees would result in the significant plummeting of forest agro diversity resulting in skyrocketing food prices. Moreover many floral species are dependent on honey bees for pollination and many local communities also depend on honey and wax as a source of livelihood (Thomas et al., 2009).

An immediate ban or safe way of disposing the cups is needed. Using closed type dustbin and frequent and periodical cleaning of the bins is necessary to prevent large-scale mortality of bees.

Contributed by S. Sandilyan, PG and Research Department of Wildlife Biology and Zoology, A.V.C. College, Mannampandal-609305, Mayiladuthurai, Tamilnadu; Email: ssandilyan@gmail.com

Clockwise from top left: Freshwater crabs in water; Freshwater crab on land; Parental care shown by the female by carrying eggs in its abdomen.

Freshwater crabs are one of the most beautiful creatures among the aquatic fauna. They can be kept in aquariums like ornamental fishes.

FRESHWATER CRABS – HIDDEN PROMISE

IN Punjab, Uttarakhand, U.P., Himachal Pradesh and Jammu & Kashmir where freshwater is the only source of aquatic fauna, people mostly rely on fishes as a source of food. However, besides fishes, freshwater bodies also hold crabs, which are a rich source of proteins, omega fatty acids, amino acids. People who live near streams are also aware of their medicinal importance.

In J&K, freshwater crabs inhabit the Jammu region because of its poikilothermic nature that restricts its distribution in the Kashmir region where the season is cold throughout the year. Compared to marine crabs, freshwater crabs are smaller in size. Freshwater crabs can be seasonal breeders or annual breeders. However, unlike marine crabs, the development is direct in freshwater crabs – eggs hatch into crablets rather than larvae.

In Jammu region, freshwater crabs such as *Maydelliathelphusa masoniana* as well as *Himalayan potomon* are found in the stream of Gho-manhasan and Tatidiyal (tributaries of river Chenab) and Jajjar and Ban Ganga stream, respectively. The life cycle of freshwater crabs is quite vulnerable to physico-chemical parameters, which can restrict their population. Being more vulnerable to aquatic pollution, freshwater crabs also act as biological indicators.

Freshwater crabs can be seasonal breeders or annual breeders. However, unlike marine crabs, the development is direct in freshwater crabs – eggs hatch into crablets rather than larvae.

In Gho-manhasan, due to increase in pollution and over-exploitation by the locals their number have shown drastic decline. Fishermen often poison the stream leading to mass mortality of the aquatic fauna including fishes and crabs. Similar is the case in the Tatidiyal stream. The lower reaches of Ban Ganga, which receive enough waste material from Gulshan Langar as well as from the upper reaches, the number of crabs exhibits a remarkable decrease. Recently, due to construction of a new road near Jajjar stream as well as dumping of wastes in the stream, the number of freshwater crabs *Himalayan potamon* has been reduced considerably.

Freshwater crabs are one of the most beautiful creatures among the aquatic fauna. They can be kept in aquariums like ornamental fishes because of their beautiful colours. The crabs have medicinal values – the exoskeleton is used to obtain chitin and chitosan that can be drawn in sheets to form antioxidant medicinal bottles as well as to prepare medicines.

However, most people are still unaware of their economic importance as well as the food value of freshwater crabs, due to which it still remains an untouched source of food that can substitute fishes. It can even open job opportunities for the people of the state by aquaculturing of these crabs.

Contributed by Rakesh Kumar Gupta, Research Scholar, Department of Zoology, University of Jammu, Jammu, J&K-180006; Email: rakeshgupta174@gmail.com

The International Space Station celebrated its 15th anniversary in November 2013 and is slated to operate for another 15 years. It is one of the biggest ever worldwide collaborative ventures in space.

The International Space Station

K. SMILES MASCARENHAS

A Russian spacecraft with two Russians and a NASA astronaut aboard docked successfully at the International Space Station on 27 March 2014. The Soyuz TMA-12M carrying Russia's Alexander Skvortsov and Oleg Artemyev and NASA's Steve Swanson is one in a series of successful landings of astronauts on the International Space Station (ISS) – one of the biggest ever collaborative ventures in space.

The International Space Station (ISS, for short) is a man-made miracle floating in space at a distance of around 400 km above us and racing at an enormous velocity of about 28,000 km/hour covering a distance equivalent to the Moon and back daily. About the size of a football field, it is the remotest man-made object that is visible to the naked eye.

The International Space Station made news in recent times when experiments on board showed that vegetables could be cultivated in micro-gravity conditions. Could this discovery pave the way for a spacecraft carrying humans to Mars and back? Only time will tell.

The idea of launching a habitable Space Station capable of housing humans for long periods of time dates back to the 1960s when science fiction writers like Isaac Asimov, Arthur C. Clarke and Edward Everett wrote many novels describing imaginary space stations in detail. All of them were aware of the absence of gravity in space.

Even though at a height of just 400 km above the earth the earth's gravitational field is still present, the reason why astronauts experience weightlessness is connected with the idea of relative motion. Since every object inside the spacecraft, including the spacecraft itself, is "falling" towards the earth at the same rate, every object inside the craft is in the same motion as the craft. This produces a feeling of weightlessness.

The writers of science fiction stories devised methods to generate gravity artificially by shaping the spacecrafts resembling giant rotating toroids. The centrifugal force produced therein creates artificial gravity, something which we have not achieved even during this century.

The International Space Station is the tenth space station in history to be launched into orbit, but is without parallel in size, scope and success.

The ISS is a milestone in both technology and international collaboration.

With the loss of the Moon race in 1969, the Russian government adopted the space station concept as the major direction for the Soviet manned programme. The dream of a space station was finally achieved when in 1971 the Russians launched their series of Salyut (meaning fireworks) spacecrafts culminating in the Salyut-7 which was

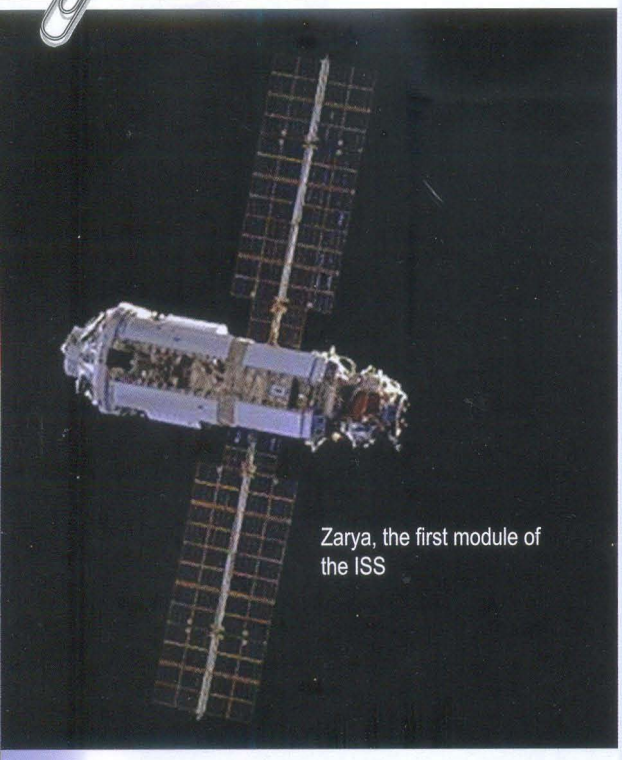
launched in 1982. Though it was crippled by severe electrical faults in 1985, it paved the way for the more advanced MIR space station.

The US joined the rat-race when NASA launched Skylab in 1973. It was the period when the Apollo project had been stopped due to scarcity of funds. This move left NASA with a spare Saturn-V rocket (which was originally intended to launch Apollo-18). Skylab was launched by this powerful rocket, but the vibrations produced by its thrust crippled the space station. The space station was finally abandoned and when the news spread that it was going to crash on earth, panic gripped every country in 1979. Luckily, the Skylab crashed in a desert in Australia.

View of Mir in space *(Credit: NASA)*

Skylab space station

Very soon it became clear that the cost of setting up a permanent earth station capable of housing laboratories for different scientific experiments was so exorbitant, that a concerted and collaborative effort from different countries was required.



Zarya, the first module of the ISS

Astronauts inside the ISS (above and extreme right)

Putting up the ISS

And thus it was that the International Space Station (ISS) started taking shape when a Russian Proton rocket placed the first piece, the Zarya module, in a low-Earth orbit about 420 km above the earth. "Zarya" (meaning Sunrise) also known as the Functional Cargo Black (FGB) was launched from the Baikonur Cosmodrome in Kazakhstan on 20 November 1998. Two weeks later, in December 1998, the space shuttle Endeavour crew attached the Unity module to Zarya initiating the first ISS assembly sequence.

It is in this manner that the ISS has been assembled in bits and pieces in space in a modular construction. It is a joint project among five participating space agencies. National Aeronautics and Space Administration (NASA), the Russian Federal Space Agency Roscosmos, Japan Aerospace Exploration Agency (JAXA), European Space Agency (ESA) and Canadian Space Agency (CSA) have worked together to build and operate the orbiting science lab in which crew members conduct experiments in biology, physics, astronomy, meteorology and other fields—one of the most complex scientific and technological endeavors ever undertaken.

The ISS celebrated its 15th anniversary in November 2013 and is funded until 2024, but may operate until 2028. The station is divided into two sections, the Russian Orbital Segment (ROS) and the United States Orbital Segment (USOS). It can be compared in size to a football field (with a dimension of about 100 m X 70 m X 20 m). It is the third brightest object in the sky seen from earth with naked eye (when the solar panels are oriented at the optimum angle with respect to the observer).

As on 2014, more than 100 missions had been launched by US, Russia, Europe and Japan from Florida, Kazakhstan, French Guiana and Japan to assemble and maintain the space station. An exhaustive timeline can be gleaned from the website: http://gizmodo.com/5185961/timeline-the-evolution-of-the-international-space-station/. The ISS serves as our gateway to deep space destinations including our moon, LaGrange points, asteroids and ultimately Mars.

The ISS orbits the Earth approximately once every 90 minutes, at a speed of about 27,700 kilometers per hour. The exact time and position of the ISS as it transits the sky from a particular geographic location can be known from NASA website (http://spotthestation.nasa.gov).

EXPEDITIONS

The ISS expeditions usually last about six months. There are 3 to 6 crew members on board all the time. Spacewalks are performed to install new components to the International Space Station (ISS), to re-wire systems, modules, and equipment, and to monitor, install, and retrieve scientific experiments.

Susan Jane Helms and James Shelton Voss conducted an 8 hour 56 minutes spacewalk during Expedition 2 on 11 March 2001, the longest to date.

Sergei Krikalev, member of Expedition 1 and Commander of Expedition 11 has spent more time in space than anyone else, a total of 803 days and 9 hours and 39 minutes.

The station also has a phone number with a Houston area code.

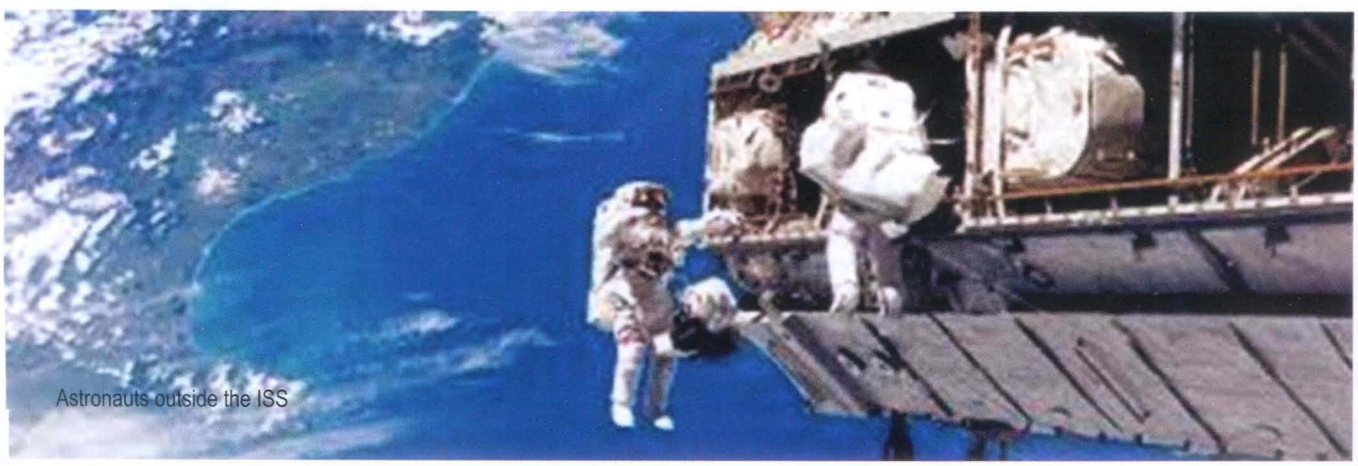
The ISS consists of pressurized modules, external trusses, solar arrays and other components. ISS components have been launched by American Space Shuttles as well as Russian Proton and Soyuz rockets. In 1984, the ESA was invited to participate in Space Station Freedom. In 1993, after the USSR ended, the United States and Russia merged Mir-2 and Freedom together.

The main difficulty in setting up a space station where astronauts could live a normal life for long periods is the ill effects of near-zero gravitational field. Almost all astronauts experienced "space sickness" as long as they were in space ships. In the absence of gravity, body fluids rose to their heads and gave them stuffy nose, nausea and headache. Less fluid in the lower parts of their bodies resulted in atrophied legs (dubbed as "bird legs"). Their heart shrunk because it did not have to work so hard in space. The ISS, therefore, is equipped with a gym with exercise machines, such as treadmills and ergometers. The astronauts exercise approximately two hours daily in order to keep their body working.

Another problem that had to be tackled was the energy lost by the space station due to the tidal effects of the earth on it. The spacecraft would slowly spiral towards the earth, with most of it burning in space. Still a large chunk could manage to survive, but if it lands in a city it can cause considerable damage.

Like any other previous Space Station, the ISS was doomed to spiral towards the earth. But periodically, the ISS receives "boosts" from visiting crafts. Without these boosts, the ISS will lose about 90 meters in altitude each day. These boosts energize the ISS and it maintains an average height of about 400 km above the earth.

The construction of toilets also provided a challenge. With a little bit of imagination you can see what happens to the excreted waste in a near-zero gravitational field! The astronauts fasten their bodies to the toilet, so that they won't float away. Then a vacuum-cleaner-like machine is operated to maneuver the waste into a disposal.



Astronauts outside the ISS

STS-110 crew eating on board the International Space Station

Inside the Space Station, the air pressure is kept at 1 atmosphere. The temperature and humidity are controlled and the astronauts can live comfortably. Therefore, except for the orange flight suits that are worn during launch and re-entry, the astronauts do not need any special clothes. The astronauts dress in the same manner that we on Earth do. However, when the astronauts venture outside the space shuttle to work in space, they wear spacesuits.

Since water does not flow in a zero-gravity environment, the astronauts cannot take a bath or wash their hands. When the astronauts want to clean their hands or faces, they either wipe themselves clean with alcohol or by using a wet towel containing liquid soap. When the astronauts wash their hair, they use waterless shampoo, which does not need

Spotting the Space Station

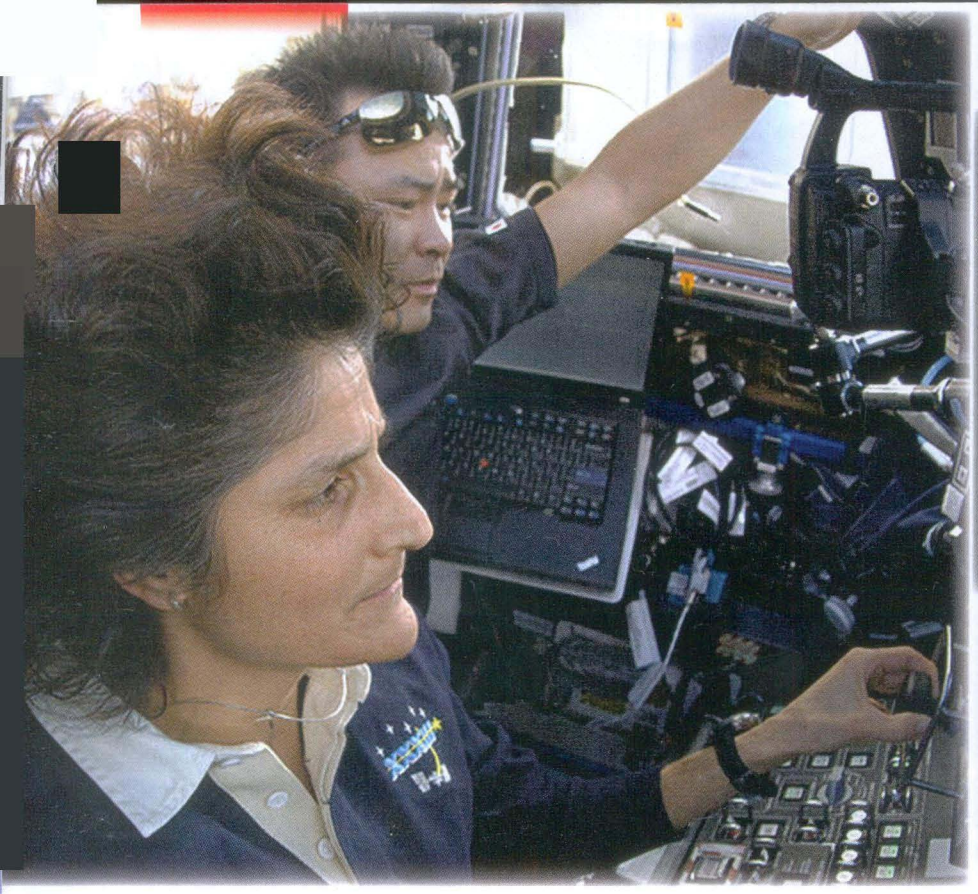
When you visit the website http://spotthestation.nasa.gov, click "Location Lookup". In "select the country", choose India and in "city" you have many major cities in India listed. Even if your city is not listed, choose the nearest city, since the ISS is visible over a very wide range. Click "Next". You will get a table like this:

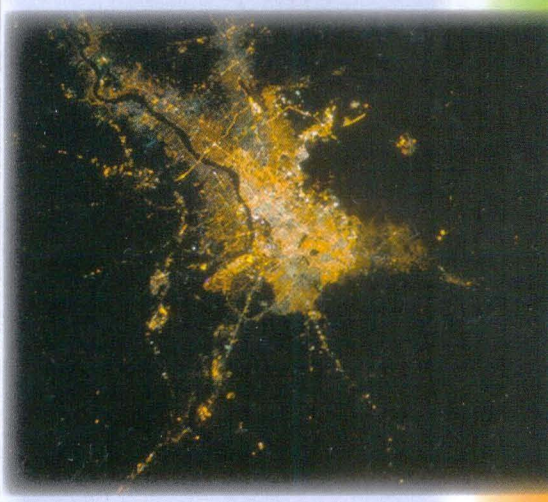
Date	Visible	Max Height	Appears	Disappears	Share Event
Fri Jan 31, 7:20 PM	3 min	22°	11 above S	21 above ESE	
Sat Feb 1, 8:09 PM	< 1 min	24°	20 above W	24 above WNW	
Sun Feb 2, 6:02 AM	4 min	58°	10 above NNW	35 above ESE	
Sun Feb 2, 7:20 PM	4 min	64°	24 above SW	19 above NNE	
Mon Feb 3, 5:16 AM	2 min	24°	21 above NNE	20 above E	
Tue Feb 4, 6:03 AM	4 min	24°	17 above W	11 above S	
Tue Feb 4, 7:21 PM	2 min	13°	3 above WNW	10 above NNW	

Choose the days when you get the Max height greater than 30° (otherwise, the satellite will be too low near the horizon), set the reminder in your mobile (the time is in IST), go to your terrace and start viewing! (ESE means east of south-east etc. All the numbers are elevation in degrees.) Sometimes you will get a message: "ISS not visible for the next 10 days." Do not lose heart! Visit the website after 10 days.

When you spot the ISS, remember that there are many scientists and technicians in it (visit the website http://spacestationlive.nasa.gov/ and click "Live Data" to know all about their activities), who are engaged in serious research work. Click more options and have fun! You will virtually end up inside the ISS!

The best option would be to sign-up for e-mail alerts. Visit the website http://spotthestation.nasa.gov/index.cfm?country=India. Register by sending your e-mail ID and get regular alerts!





From far left: Meals on board the ISS; Sunita Williams on the ISS; and Calcutta by night (as seen from the ISS).

The writers of science fiction stories devised methods to generate gravity artificially by shaping the spacecrafts resembling giant rotating toroids.

any water for rinsing. Waterless shampoo is used since it has no foam, which could spatter inside the Space Shuttle. After washing, they use dry towels to dry themselves.

While drinking liquids, a straw is used to suck the liquid out of a sealed package. This is done so that it will not spill or possibly cause any damage to machines.

Preparation of food varies with the food type. Some foods can be eaten in their natural forms, such as salads, fruits and nuts. Other foods require adding water or milk, such as cheese and spaghetti. This is done in closed containers, since under microgravity food can float! Of course, an oven is provided in the space station to heat foods to the proper temperature. There are no refrigerators in space, so space food must be stored and has to be prepared properly to avoid spoilage, especially on longer missions. The storage area is kept where the Sun's rays are intercepted minimally.

The Astronaut's Day

A typical "day" (a "day" cannot be specified in terms of the rising and setting of the Sun, since on the ISS the Sun rises and sets every 90 minutes and the crew members aboard the International Space Station experience 15 or 16 sunrises and sunsets every day!), in the life of an astronaut aboard the space ship can be as follows:

1. Go to the toilet and attend to the morning chores.
2. Have "breakfast". Then take blood samples for analysis and check the day's schedule with the mission control
3. Do air quality checks and start work on allotted experiments.
4. Exercise for an hour and at the end, take "lunch".
5. Take a small break. Do a little bit of maintenance and system check. Back to the experiment and other allotted work.
6. Another hour of exercise.
7. Finish assigned tasks. Clean up working spot.
8. Evening meal and conference to plan the next day. Go to sleep.

Visit the website http://spacestationlive.nasa.gov/ and click "Live Data". You will know what each astronaut is doing at the present moment!

Scientific Experiments on ISS

The ISS serves as a microgravity and space environment research laboratory suited for the testing of spacecraft systems and equipment required for missions to the Moon and Mars. The experiments span several areas.

a. Technology Development—studies and tests of new technologies for use in future exploration missions, such as spacecraft materials and systems, and characterization and control of the microgravity environment on ISS.

b. Physical Sciences—studies of physics and chemistry in microgravity such as materials sciences experiments, including physical properties and phase transitions in polymers and colloids, fluid physics, and crystal growth experiments.

c. Biological Sciences—studies of biology using microgravity conditions to gain insight into the effect of the space environment on living organisms including cellular biology and biotechnology, and plant biology.

d. Human Research for Exploration—human medical research to develop the knowledge that is needed to send humans on exploration missions beyond Earth orbit. These studies focus on the effect of living in space on human health and countermeasures to reduce health risks that will be incurred by living in space in future. Areas of emphasis include physiological studies related to the effects of microgravity on bone and muscle, other physiological effects of space flight, psychosocial studies, and radiation studies.

ROBOTS ON BOARD

Humans are not the only residents on the station. The ISS also has robots aboard.

CSA's Canadarm2, also known as Space Station Remote Manipulator System (SSRMS) was critical to assembling the space station and continues to support the orbital complex by latching onto and attaching or detaching unmanned resupply spacecraft as needed.

Robonaut 2, inside the space station's Destiny lab (NASA)

JAXA's Kibo laboratory has its own robotic arm, the JEM-RMS (Japanese Experiment Module Remote Manipulator System) has two arms – the Main Arm (MA) and the Small Fine Arm (SFA) used to tend to experiments mounted outside on the module's exposed platform (or porch).

Canada's Dextre, also known as Special Purpose Dexterous Manipulator (SPDM), is a detachable two-armed robot performing maintenance work and repairs outside the ISS, thus reducing the spacewalks.

The product of a partnership between NASA and General Motors, Robonaut 2 (R2) was the first humanoid robot to fly into space and first to be able to work side-by-side with astronauts. Capable of being controlled by the space station crew or by ground controllers, Robonaut 2 can use the same tools as used by humans.

e. Observing the Earth and Education— these activities and investigations allow students and the public to connect with the ISS mission, inspiring them to excel in science, technology and engineering. They share the astronauts' unique view of the Earth system with scientists and the public.

In addition to the formal, peer-reviewed scientific research and experiments, the ISS supports a large body of research using data from ISS operations, including routine medical monitoring of the crew and data that are collected on the ISS environment, both inside and outside of the ISS.

A series of experiments studying complex plasma is taking place on board the international space station. These experiments can be done only in microgravity and physicists will use these experiments to study fundamental structure forming processes.

The Alpha Magnetic Spectrometer (AMS) – which is searching for elusive dark matter – is one of the key science experiments featuring in the ISS extension to 2024. The AMS is the largest research instrument on the ISS. The extension will enable NASA, the academic community and commercial industry to plan much farther in the future and consider ideas not even possible if the station was de-orbited in 2020 according to the existing timetable.

For a list of all the scientific experiments that are being carried out in the ISS, visit: http://www.nasa.gov/mission_pages/station/research/experiments/experiments_by_name.html.

Since the arrival of the first expedition on 2nd of November 2000, the station has been continuously occupied for more than 13 years, the longest continuous human presence in space. (In 2010, the station surpassed the previous record of almost 10 years or 3,634 days held by Mir.) The station is serviced by a variety of visiting spacecraft: Soyuz, Progress, and the Automated Transfer Vehicle. It has been visited by astronauts and cosmonauts from 15 different nations.

After the U.S. Space Shuttle program ended in 2011, Soyuz rockets became the only provider of transport for astronauts at the International Space Station.

Skylab was launched by this powerful rocket, but the vibrations produced by its thrust crippled the space station. The space station was finally abandoned and when the news spread that it was going to crash on earth, panic gripped every country in 1979. Luckily, the Skylab crashed in a desert in Australia.

Students' Involvement with the ISS

During their summer vacation, all students can spend their time usefully by chatting with the astronauts, downloading valuable information regarding space science, getting photographs of earth from space etc., by visiting the following websites:

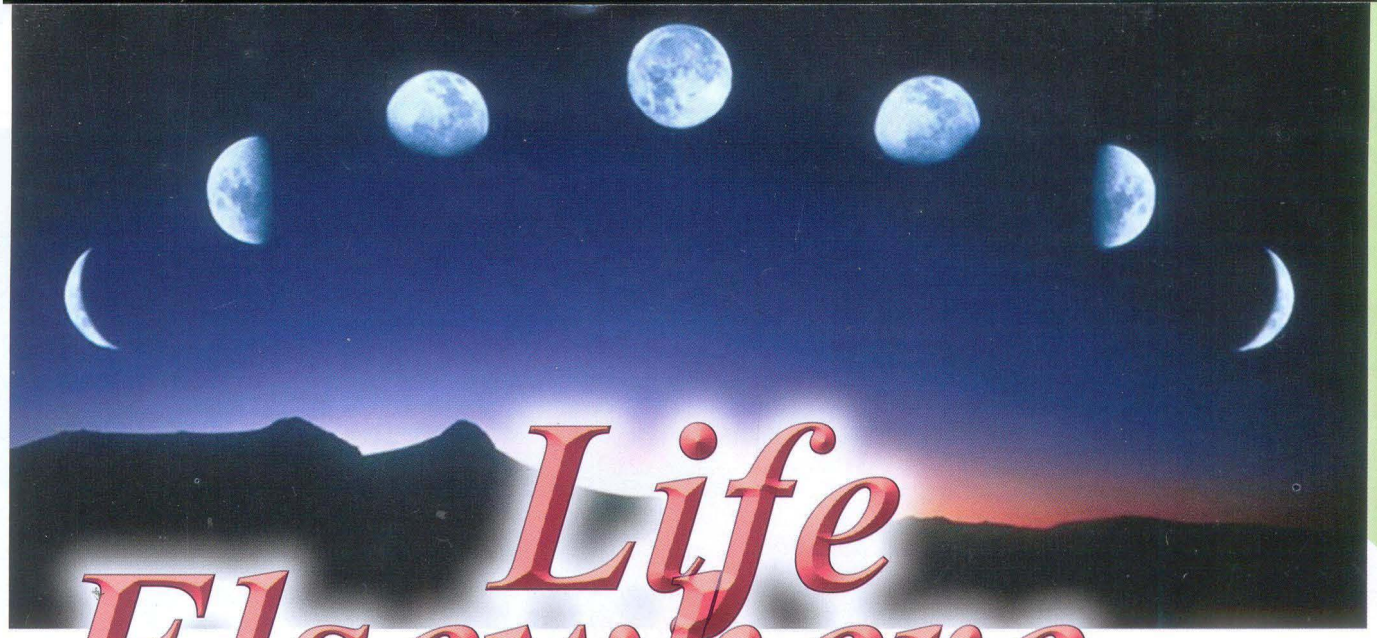
1. http://www.nasa.gov/mission_pages/station/main/
2. http://www.nasa.gov/audience/foreducators/teachingfromspace/students/ariss.html#.UwGR3n8e4wo
3. http://www.nasa.gov/audience/foreducators/teachingfromspace/dayinthelife/eating-adil-index.html

India's Involvement with ISS

ISS has invited other countries, including India, to conduct experiments on board the ISS. The Chairman of ISRO recently said: "India is not a partner for now in the International Space Station. We are in discussion whether we could do something on climate related earth observation system experiments. Initial discussions are on." We can soon expect an astronaut of Indian origin on board the ISS.

The International Space Station is the tenth space station in history to be launched into orbit, but is without parallel in size, scope and success. And while there is only one International Space Station, it has come to serve multiple purposes. The ISS is a milestone in both technology and international collaboration.

Prof. K. Smiles Mascarenhas is Dean (Academic Affairs), Coimbatore Institute of Engineering and Technology, Narasipuram Post, Coimbatore-641109



Life Elsewhere in the Universe !

HARI OM VATS

The possibility of life elsewhere in the universe has always fascinated humans. Over the years, however, space probes to most planets have busted several myths. Till such time as we gather concrete evidence let us be logical and base our arguments on scientific evidence.

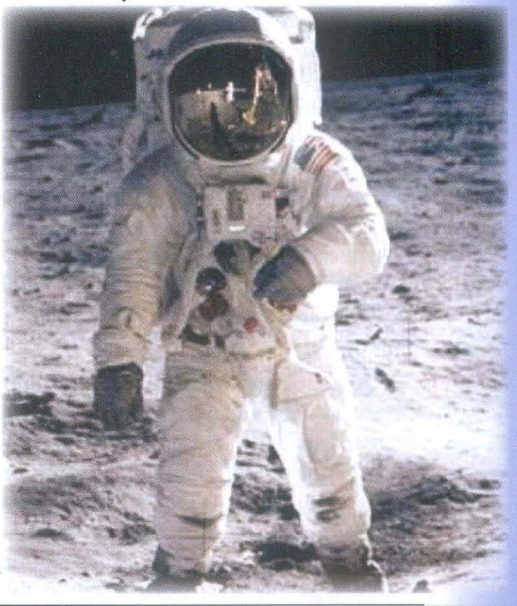
HUMANS have always been fascinated by the concept of life on planets and stars other than the earth. Highly evolved humans, strange looking creatures, complex machine-like forms or even a mixture of all these have always been conjured.

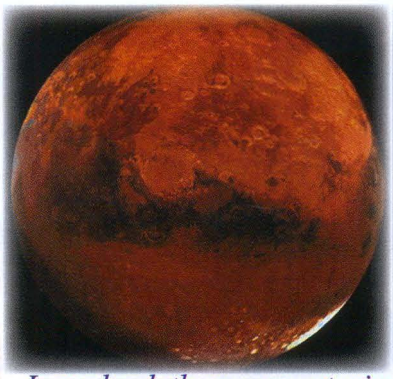
Long back there were stories and even reports in newspapers claiming that there were plants and animals on the moon and that through a big telescope we could see them. Some believed that there were trees. Big melons grew on them. Animals that looked like small buffaloes grazed beneath the trees. Animals looking like bears walked around on their hind legs.

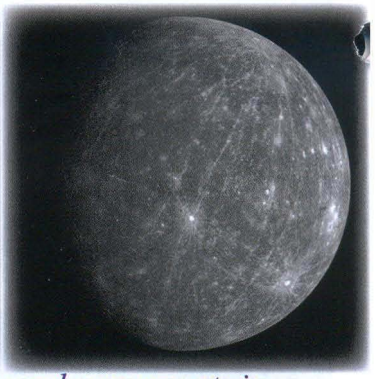
There were stories claiming the presence of people on the moon too. They had hair all over their bodies and wings. The moon people were friendly, one such story said. Some of them sat near a pond feeding melons to one another. For a long time people believed in these moon creatures.

There was once a radio story that said Martians had landed on Earth. That they had big heads and small bodies. They came in space ships. They were not friendly. Once they landed, they spread out and attacked people in towns and villages.

One such supposed event was discussed among a group of physicists at the University of Chicago during a lunch meeting in 1950 with physicist Enrico Fermi. A group of neighbourhood kids had apparently stolen garbage can lids and tossed them like Frisbees in front of people's windows. Neighbours thought the whizzing disks were UFOs from otherworldly visitors.







Long back there were stories and even reports in newspapers claiming that there were plants and animals on the moon and that through a big telescope we could see them.

By the 1960s, only a few people still believed there were Martians or moon people. In 1969, however, everyone knew for sure that there was no life of any kind on the moon. That was the year Neil Armstrong and Edwin Aldrin walked on the moon. The astronauts found nothing alive. They found no sign that plants or animals had ever lived there. The moon is a dead world and it always has been so.

But still people believed that the moon landing did not mean there was no life on other planets. Many believed that Mars was habitable and hosted standing bodies of water several billion years ago. Mars is like Earth in many ways. Pictures of Mars show places where water once flowed. Where there is water, there may also be plants and animals. Did plants and animal once live on Mars? Could they be living still?

Space probes were sent to Mars, pictures were taken. The soil of Mars was tested. No plants or animals of any kind were seen. The temperature on Mars varies from -140° C to 20° C. No signs of life were found in the soil. In some aquifers of Mars there may hopefully be water that erupts episodically to the surface, and so there may be extant life in those locations. Recent measurements by Curiosity Rover have shown evidence of small amount of water in the soil and fine dust of Mars.

Mercury and Venus are the planets closest to the Sun. Probes were sent to Mercury to get a closer look. Mercury does not look like a place where plants or animals could live. It looks like the dead world of the moon. Mercury is the planet closest to the Sun, so one would assume that it is a burning furnace. While the temperature on Mercury can reach 465° C, it can also drop to frigid temperatures of -184° C. There is such a big variation in Mercury's temperature because the planet has no atmosphere. Mercury gets very hot, much too hot for anything to live there.

Venus, the second closest planet to the Sun, has the highest average temperatures of any planet in our Solar System, regularly reaching temperatures over 460° C. Venus is so hot because of its proximity to the Sun and its thick atmosphere. Venus' atmosphere is composed of thick clouds containing carbon dioxide and sulphur dioxide. This creates a strong greenhouse effect, trapping the Sun's heat in the atmosphere and turning the planet into a furnace. No signs of life have ever been found on Venus.

After Earth, the four outer planets in our solar system are gas giants. Jupiter has no solid surface. At the top of Jupiter's clouds, the temperature is around -145° C. As you descend closer to the centre of the planet, the temperature increases. At the point where atmospheric pressure is ten times greater than it is on Earth, the temperature is 21° C, which scientists call "room temperature." At the core of the planet, the temperature is much higher, reaching approximately 24,000° C at the core. The core of Jupiter is hotter than the surface of the Sun.

Because of Saturn's tilt, the southern and northern hemispheres are heated differently causing seasonal and temperature changes. Like on Jupiter, the temperature in the upper atmosphere of Saturn is cold – up to approximately -175° C and increases closer to the centre of the planet.

Uranus is the coldest planet with the lowest recorded temperature of about -224° C. Although Uranus is far from the Sun, that is not the only reason why it is so cold. All of the other gas giants in our Solar System give off more heat from their cores than they receive from the Sun. Uranus has a core of about 4,737° C, which is only one-fifth the temperature of Jupiter's core, thus giving out much less heat from its core.

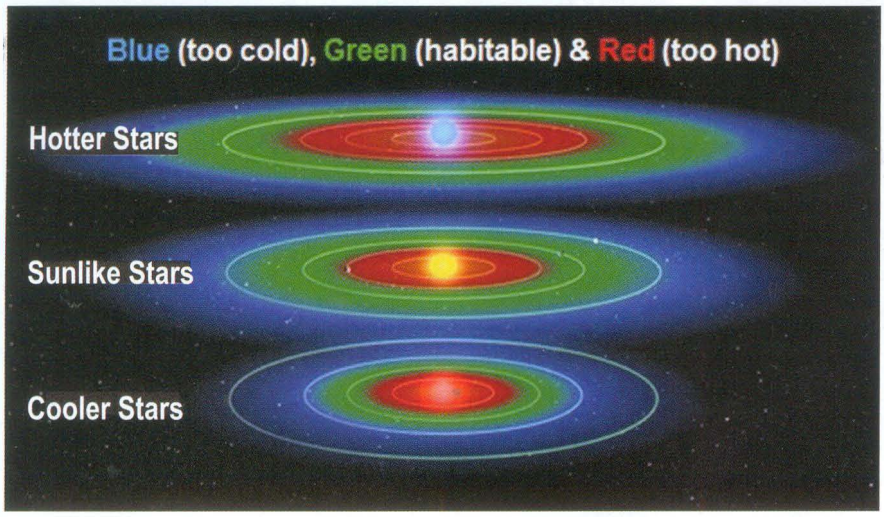
With temperatures dropping to -218° C in Neptune's upper atmosphere, the planet is one of the coldest in our Solar System. Like all the gas giants, Neptune has a much hotter core, which is around 7,000° C. Jupiter, Saturn, Uranus and Neptune are made up of gases and are also very cold, much colder than any place on Earth.

Thus in our solar system, Earth seems to be the only planet where we know for sure there is life.

Europa and a number of other moons in the outer Solar System have interior water. Titan could host an alternative mode of biochemistry based on ethane and methane.

The Drake equation is a probabilistic argument used to estimate the number of active civilizations in the Milky Way galaxy. The equation was written in 1961 by Frank Drake. It has four factors. Though the values of these factors in the Drake equation are not known, it is still a useful tool for organizing our thinking.

The factors are the number of habitable planets in the galaxy, fraction of life bearing planets, fraction of civilizations capable of interstellar communication and fraction of such



There may perhaps be millions of such worlds in the universe where creatures may know as much as we do. Some may be a lot smarter.

civilization now as opposed to millions and billions of years in the past. With pure conjecture it predicts ~10,000 detectable civilizations in our own galaxy "the Milky Way". There are billions of stars beyond our solar system. There are planets around some of these stars, just as Earth goes around the Sun.

The decades old (~50 years), Search for Extra Terrestrial Intelligence (SETI) experiment has not yet detected any radio signal. But it is argued that this is too short a time in comparison to billions of years that the universe has been around. The civilizations must have come and gone without our knowing that they existed. The absence of evidence is not evidence of absence.

The discovery of extraterrestrial intelligence would be one of the most important ones in human history. To communicate would require means and motivation. After all we can talk to animals that share 99% of our DNA.

May be new facilities, like the Allen Array Radio Telescope which includes 350 antennas, each with diameter of 6 metres will help us get in touch with the technologies of other worlds soon.

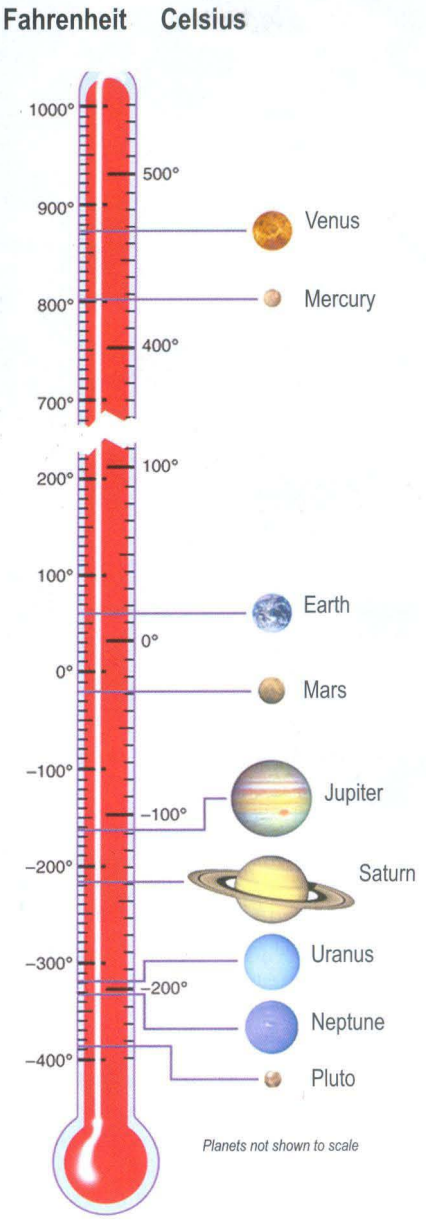
The Kepler mission was launched in March 2009. This is a part of the Exoplanet Exploration Program of NASA to find planets (one-half to twice the size of the Earth). The main aim is to search for planets in the habitable zone of a star in our galaxy. The habitable zone of a star is the area around the star where the composition and atmospheric pressure can maintain liquid water on its surface. There life can be supported as we know.

The Kepler mission has a specially designed 0.95 meter telescope with a photometer. The detection is based on the principle of transit. When a planet crosses in front of its star as viewed by an observer, the event is called transit. The transit by an earth-size planet produces a small change (~100 part per million (ppm)) in the light curve of the star. The change must be periodic if it is caused by a planet.

From the detailed analysis of a planet's orbital size, characteristic temperature can be estimated. These are essential to learn whether or not the planet is in a habitable zone. The telescope simultaneously and continuously monitors the brightness of more than 100,000 stars. This can detect planets as small as 0.8-2.2 times the size of the Earth.

The mission has already discovered more than 3000 candidate and confirmed planets, more recently three more planets, in the habitable zone of their star. The astronomers are focussing their search mainly on stars of F, G and K types. These have longer lifetimes

The major biogenic elements are carbon, nitrogen, oxygen, sulphur and phosphorous. These are routinely created within stars and then ejected out into the interstellar space where they become part of the next generation of stars and planets. Models suggest that biochemistry could have begun within a billion years of the Big Bang. As the universe ages, and more carbon is produced, it gets more hospitable for life.



Although not discovered until now, it might be possible that somewhere out among the billions of stars, there must be plants and animals living on other worlds. There may perhaps be millions of such worlds in the universe where creatures may know as much as we do. Some may be a lot smarter. One day we may be able to talk with them. Many years from now we may even travel to those far-off planets and land on them.

But till such time as we gather concrete evidence let us be logical and base our arguments on scientific evidence.

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KAMALAKANTA JENA

Creating an Artificial Star

Astronomers are employing powerful lasers to create an artificial star, which acts as a guide star to study distant targets in space.

OUR vast universe has not lesser than 70,000,000,000,000,000,000,000 stars, although not more than 5000 stars are seen with our unaided eyes. Astronomers analyze light, heat and other radiations they receive from distant stars and galaxies to understand the universe that was created probably 13.7 billion years ago from an extremely dense hot situation and has been expanding. They try to explicate the mysteries behind such amazing creation.

But the radiations have to travel all along the thick atmosphere before reaching the astronomers often obscuring their view of celestial objects. The radiations from distant objects often get absorbed or distorted by the atmosphere.

Astronomers have long been trying to avoid atmospheric intrusion. In order to receive images of much greater brightness, clarity and detail than ground-based telescopes, they sent into space the $2 billion Hubble Space Telescope. The sophisticated optical observatory was placed into orbit about 600 km above the Earth on 25 April 1990 by the crew of the space shuttle Discovery.

But, not many agencies can afford to launch such billion dollar outer space telescopes. Astronomers worldwide then turned their attention to focus mountaintops in Hawaii, Chile and the southwestern United States for mounting a new generation of powerful telescopes.

The new sophisticated eyes include the Keck-I Telescope with a main mirror 10 metre in diameter, the 8.3 metre Subaru Telescope, the European Southern Observatory's Very Large Telescope with four 8.2 metre primary mirrors and several others. These sophisticated structures promise fresh insights into how the universe took on its structure, and how galaxies, stars and solar systems develop. In addition, much cheaper advanced technologies like active optics and adaptive optics ensure sharp and steady images from them.

Active and Adaptive Optics

Active Optics and Adaptive Optics are two new technologies employed in giant telescopes to make images as sharp and steady as possible. Active optics on a longer timescale corrects changes that

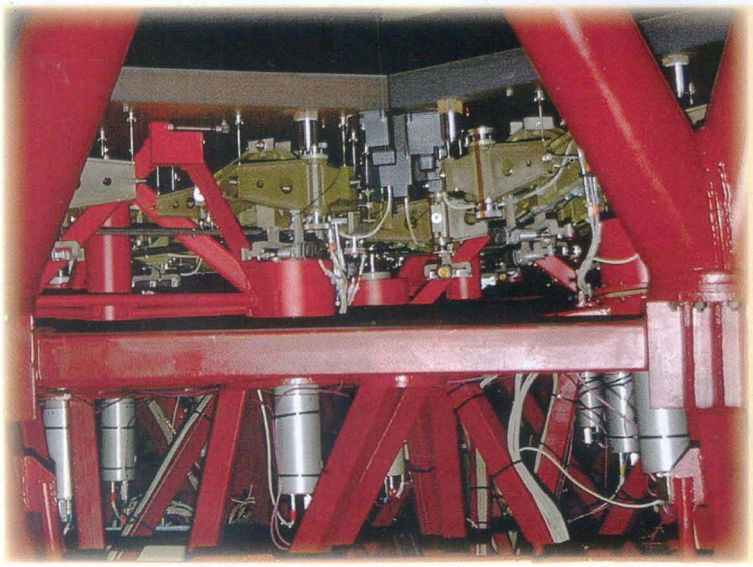
Four Unit Telescopes form ESO's Very Large Telescope

occur in the shape of the primary mirror which is used in the telescope to converge the radiations incident on its surface. Adaptive optics compensates for much of the distortion produced as the light from a celestial object passes through the atmosphere above the telescope.

Active Optics: Huge primary mirrors used in giant telescopes may get twisted by uneven shrinkage through heat during day or dampness in night. They may be distorted by the gravitational pull, mechanical stress or sudden violent rush of wind. Even if they go out of shape slightly, it would hamper the sharpness and steadiness of the images.

But active optics, developed in the 1980s, corrects changes that occur in the shape of the primary mirrors in order to produce the best image. This is done with computer control of the push-pull actuators on the back of the mirror. It could tilt the secondary mirrors of the giant telescopes slightly or move it up and down for better focusing. The construction of neither 8-metre class telescopes nor telescopes with segmented mirrors would be feasible without active optics.

Adaptive Optics: The atmosphere is constantly changing, with warm air rising, cold air sinking, and winds mixing



Actuators of the Active Optics of the Gran Telescopio Canarias

Distorted signal received from distant star is sent to small computer-controlled motors, which bend and twist the shape of the telescope's mirror accordingly.

together. Light is affected by the medium in which it propagates as is evident from twinkling of the stars. So turbulence in the atmosphere distorts signals from astronomical objects. Thus rapid changes in the orientation of mirrors of telescopes are required to correct for the constantly varying image distortions. Twisting massive mirrors back and forth rapidly through active optics may not be easy.

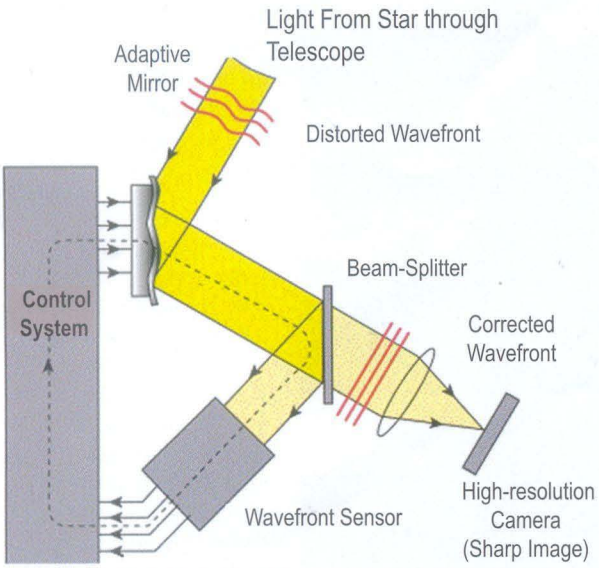
Adaptive optics, first envisioned by American astrophysicist Horace Welcome Babcock in 1953, employs a rubber mirror to compensate for much of the distortion produced by atmospheric commotion. In fact, the mirror is not made of rubber but of optical materials like glass. Hundreds of small actuators are glued to the back of the deformable mirror.

The mirror inserted in the light path is flexible enough to adapt its shape, under computer control to correct for distortions in the image of a special star, called reference star, a relatively bright star located in the same field of view as the distant object under study. The wave upon reflection from the adaptive mirror emerges the way it was before it entered the atmosphere. It results in a sharp image as if the atmosphere were not present.

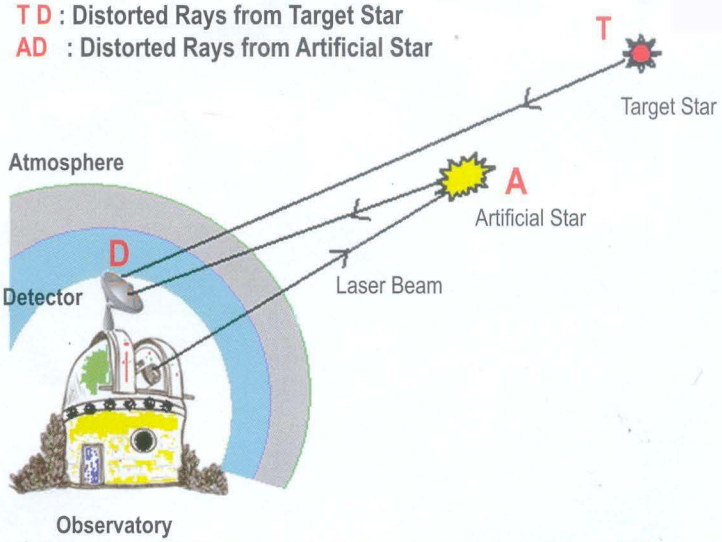
Creating an Artificial Star

Adopting adaptive optics is a complicated process. The possible difficulty in using adaptive optics is the unavailability of a nearby appropriate reference star. Not only the reference star has to be relatively bright but it should be burning within the stipulated area of the sky adjacent to the celestial body under survey. To overcome this limitation, astronomers artificially create a suitable star when and where they need it. This star is what we call an artificial star.

MECHANISM OF ADAPTIVE OPTICS



ANALYSIS OF DISTORTED RAYS COMING FROM TARGET STAR AND ARTIFICIAL STAR



Astronomers employ a powerful laser to create the artificial star. They shine the powerful laser beam from the observatory in the general direction of the distant target star under study. The laser beam which is trained through the telescope shines at a well-defined wavelength. Wavelength, being a basic characteristic of any wave, determines the behaviour of the laser. The laser beam stimulates the layer of sodium atoms present in the upper atmosphere. The atoms absorb energy from the incident laser and glow producing a bright spot of light, which is known as artificial star or laser guide star (LGS).

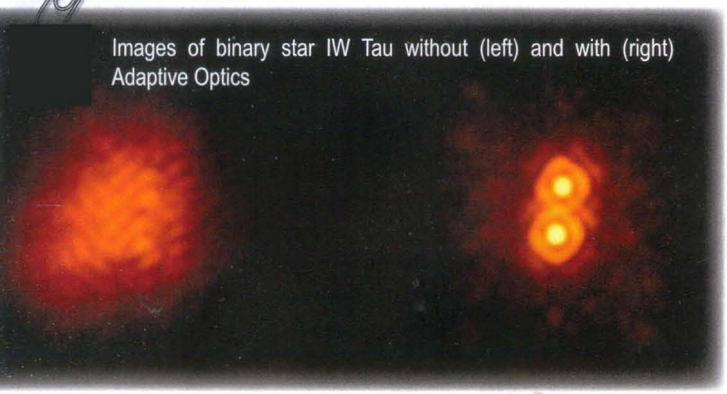
Laser beam directed toward the centre of the Milky Way to create a guide star

This comes under Sodium Guide Star (SGS), which is one of the two flavors of LGS, the other being Rayleigh Guide Star (RGS). SGS uses laser light to excite sodium atoms in the upper layers – mesosphere and thermosphere – of our atmosphere. SGS works by propagating a laser of 589 nano-metre wavelength. On the other hand, RGS, simpler and less costly, works by propagating a laser usually at near ultraviolet wavelength, and detecting the backscatter from air at altitudes between 15 to 25 km.

Cosmic Information through Artificial Star

The observatory keeps information about the laser guided artificial star. A part of the laser light reflects back through the atmosphere to the observatory. Special detectors at the observatory analyze these reflected rays. The reflected lines are compared with original incident lines. This is how degree of atmospheric distortion of the beam can be determined.

The light coming back to the telescope from the gleaming artificial pustule undergoes nearly the same distortions as the light coming down from the distant celestial target located



Images of binary star IW Tau without (left) and with (right) Adaptive Optics

The possible difficulty in using adaptive optics is the unavailability of a nearby appropriate reference star. Not only the reference star has to be relatively bright but it should be burning within the stipulated area of the sky adjacent to the celestial body under survey.

in the same direction. The true shape of the laser guide star is already known from laboratory tests of the laser. It helps to know nearly the true shape of the signal coming from the target star.

The distorted signal received from the distant star is sent to small computer-controlled motors, which bend and twist the shape of the telescope's mirror accordingly. Deforming the mirror makes up for the distortion caused by the atmosphere. A significant fraction of the aberration introduced by the atmosphere can be removed in this way and remarkably sharp images are produced.

Future of Artificial Star Technology

Laser guide star adaptive optics is still a very young field, with much effort currently invested in technology development. The first artificial star was created in the southern hemisphere on 28 January 2006. Scientists at the European Southern Observatory's Very Large Telescope (VLT) at Cerro Paranal (Chile) succeeded in creating the first artificial glittery pustule with the help of a powerful laser beam.

The beam was launched from the 8.2 m fourth telescope Yepun to create their star at a height of 90 km. It was about 20 times fainter than the faintest star that can be seen with the unaided eye, but bright enough for the research team. The observations at Palomar Observatories (California) and Keck Observatory (Hawaii) were also then published in peer-reviewed scientific literature.

LGS systems are under development at most major telescopes like the William Herschel Telescope, Gemini North, Large Binocular Telescope and Gran Telescopio Canarias. The experience gained with the laser guided star is also a key milestone in the design of the next generation of Extremely Large Telescope with the 30-60 metre range mirrors, whose study has already been initiated by European Southern Observatory together with the European Astronomical Community.

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SWATI SAXENA

Lagrange Points in Space Exploration

Lagrange Points – the gravitationally stable locations in space – have aided and accelerated human space exploration by several folds.

MOST of us have often wondered what is it that keeps satellites hanging in mid-space. Well, in our science class, we learn about three types of equilibrium states: neutral, meta-stable and stable. These equilibrium states can be physically described as akin to a ball on a plane, saddle point and at the bottom of the concave bowl respectively (See Figure 1).

These equilibrium points can result due to the balance of two forces in space as in the case of Lagrange points. Newton's law of universal gravitation states that any two bodies in the universe exert force on each other dependent on their masses and the separation distance between them. A gravitational field thus surrounds every point mass with varying intensity. The motion of the bodies in the gravitational force can be explained by Kepler's laws of orbital motion.

There are locations in space in a two-body system where the forces of gravity and orbital motion balance each other out, creating small regions of orbital stability. These points are named after an Italian-French mathematician Joseph-Louis Lagrange (1736-1813), who worked out their locations in 1772. They are also known as libration locations.

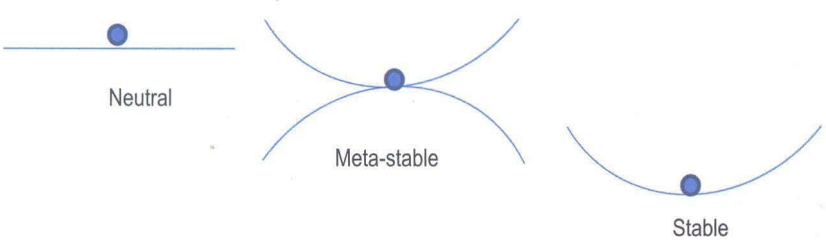
Joseph-Louis Lagrange published his results in his gravitational studies of the 'General Three body problem': how a third, small body would orbit around two orbiting large ones. In a two-body system such as Sun-Earth, there are five of these stability regions.

These locations have greatly contributed to space exploration and have become popular abode to the several space observatories in the last few decades. The points that are of most interest to us are the five Lagrangian points in the Sun-Earth system and five in the Earth-Moon system.

An object placed at a Lagrange point will be in a state of gravitational equilibrium, and will orbit the larger body with the same period as the bodies in the system. In other words, in the Earth-Moon system, an object in a Lagrange point will keep pace with the Moon in its orbit about Earth. The third particle can rotate at a constant relative speed with respect to the two bodies if placed at one of the Lagrangian points.

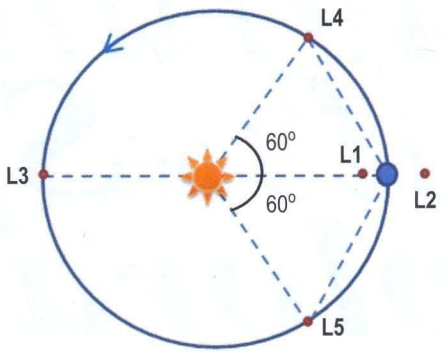
Joseph-Louis Lagrange (1736-1813)
(Credit: Wikipedia)

Fig 1. **Different States of Equilibrium**



The first Lagrange point, usually abbreviated L1 (see Figure 2), is located directly between the primary body

Fig 2. **Sun-Earth Lagrangian Points System**



Since the position of L3 lies behind the Sun, any object that may be orbiting there cannot be seen from Earth. As of now, no satellite or observatory is planned to position at Sun-Earth L3.

(Sun or Earth) and its satellite (Earth or Moon). In the Earth-Moon system, the L1 point is roughly 200,000 miles (323,110 kilometers) away, or roughly 84% of the way to the Moon.

The L2 point lies in direct line with the L1 point, but at a distance of some 37,000 miles (60,000 kilometers) behind the Moon in the Earth-Moon system. The L3 point also lies along the same imaginary line of L1 and L2, but on the opposite side of primary body from the satellite, in the satellite's orbit.

L2 is a great place from which to observe the larger Universe. A spacecraft at L2 would not have to make constant orbits of Earth, which would have kept changing its view and also the surface temperature due to the variability in the position relative to the Sun. Free from this restriction and far away from the heat radiation, L2 provides a much more stable viewpoint.

The L1, L2, and L3 Lagrange points are all in metastable or unstable equilibrium. The forces of gravity and orbital motion are precisely balanced at these points, but even a slight nudge will send any object at them drifting off as in the case of a saddle point. Because satellites, even in the vacuum of space, are not completely devoid of forces acting on them (such as due to solar wind, meteors and asteroids), anything placed at the first three Lagrange points will need periodic course corrections to keep them in place. For example, a satellite at one of these three regions will need occasional thrusters to keep them in the orbit.

In 1956, the Polish astronomer Kordylewski discovered large concentrations of dust at the Trojan points of the Earth-Moon system. For large space structure whose course corrections in other orbits would require large expenditures of fuel and energy, this is a very attractive option.

Figure 3 shows the gravitational potential lines in white for the Sun-Earth system with the Lagrange points L1 to L5. The blue triangles are enhanced regions of repulsion and the right triangles show regions of enhanced attraction (towards the libration point).

The L4 Lagrange point lies 60 degrees trailing the satellite (Moon) in its orbit, and the L5 Lagrange point lies 60 degrees spin ward of the satellite (Moon) in its orbit, about 238,000 miles from both the Moon and Earth, forming an equilateral triangle with those bodies. These are also called the Trojan Points, after the asteroids Agamemnon, Achilles and Hector that orbit in the L4 and L5 points of the Jupiter-Sun system. There are several natural bodies including moons, minor planets, and asteroids in the solar system that orbit near Trojan points. There are several thousand known Trojan minor planets orbiting the Sun. Most of these minor planets orbit near Jupiter's Lagrangian points.

Unlike the first three Lagrange points, L4 and L5 offer more orbital stability because of Coriolis force. A gentle push at an object at these points will not send it drifting away, but will instead put it into "orbit" around the Lagrange point as represented by closed white constant potential lines around L4 and L5 in Figure 3. Unlike the other Lagrange points, L4 and L5 are resistant to gravitational perturbations. Because of this stability, objects tend to accumulate in these points, such as dust and some asteroid-type objects.

Orbits around L4 and L5 include horseshoe orbits, tadpole orbits and quasi-satellites. An example of a body in a tadpole orbit is Polydeuces, a small moon of Saturn which librates around the trailing L5 point relative to a larger moon, Dione.

In the last few decades, several space crafts equipped with instruments of different capabilities have been launched towards the Earth-Moon and Sun-Earth Lagrange points to perform the assigned observations. Several future space projects of NASA and European Space Agencies have been planned where these stability zones will either serve as a permanent home or an outpost. Some of the current and future space explorations are described next.

Earth-Moon Lagrange Points in Space Exploration

L1: "Gateway" Station

For large-scale exploration and colonization of the Moon, NASA has long since envisioned a "staging base" station at the Earth-Moon L1 point. An L1 Gateway station would have a number of important functions. One, it is in a perfect location to monitor and coordinate communications among various expeditions and missions on the nearside of the Moon.

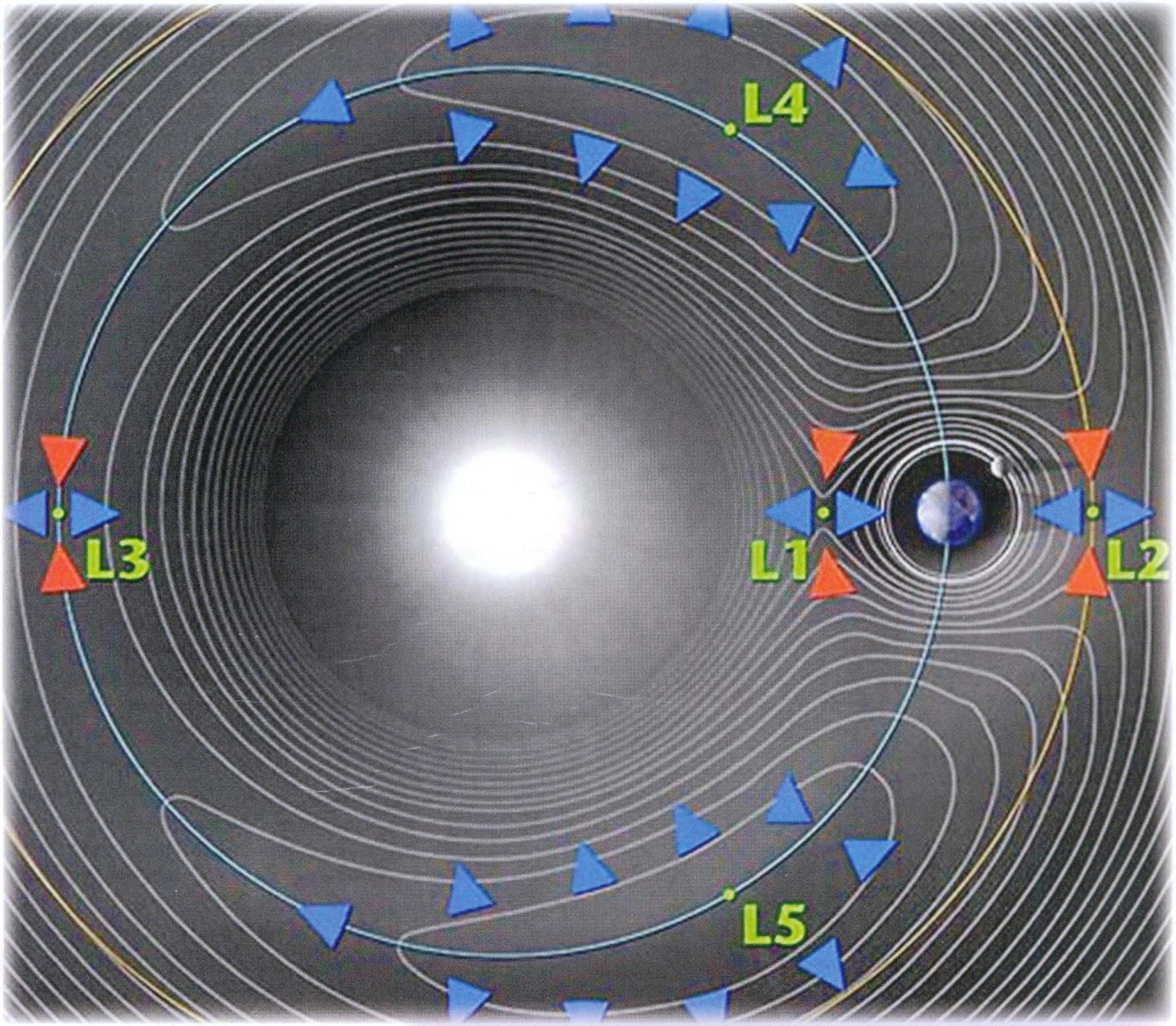


Fig 3. Gravitational potential (white lines) associated with the Sun-Earth system.
(Credit: NASA WMAP Science Team)

A vessel launched from L1 could reach anywhere on the Moon within a few hours, which would make it ideal for coordinating and initiating crisis management. Also, it would function very much as a way-station, especially once built up, and would probably be used to handle tourists and visitors to Moon.

The Gateway can also serve an important function as storage and repair center. It can help in repairing trans-lunar spacecraft. Eventually, the station can temporarily store raw materials collected from Moon until they are brought back to Earth.

L2: Far-side Communication

A far side halo satellite can be used on the L2 Lagrange point on the far side of the moon. It would be set up in a broad orbit perpendicular to the plane of the Moon's orbit. This would give it the unusual property of always being visible from Earth at every point in its orbit, inscribing a circle in the sky slightly larger than that of the moon itself.

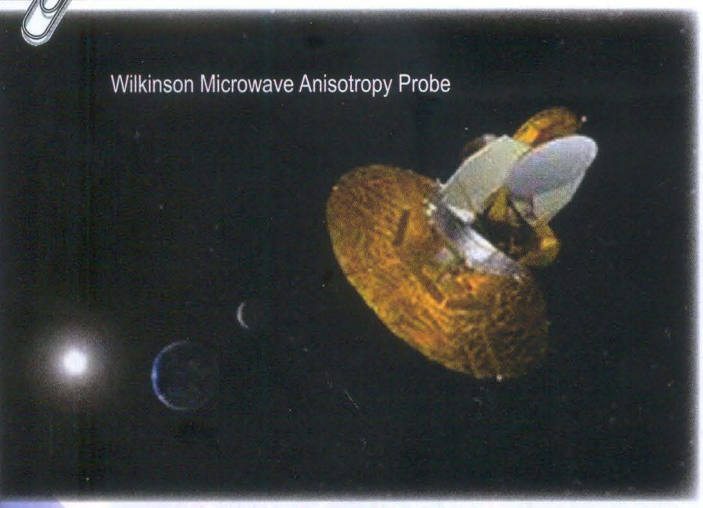
In other words, to an observer on Earth, the satellite's rounded path in the sky would always circle the disk of the moon but never slip behind it. However, maintaining a halo orbit around a metastable Lagrange point will have to be constantly monitored for necessary course corrections.

As an orbital infrastructure grows, numerous structures including colonies, stations, and automated satellites would likely be seen circling these Lagrange points in halo orbits.

Astronomical Observatories' "out-post"

The L2 point lies some 35,000 miles beyond the Moon, and thus provides an unprecedented stable venue for astronomical instruments away from Earth's radiation and radio noise. Space-based radio telescopes are a proven technology, but one has never been placed so far out in space. Also, because L2 is metastable, periodic station-keeping would be required.

Recently, NASA has proposed to start building a small outpost in 2017, likely with parts left over from the $100 billion International Space Station, at Earth-



Lagrange published his results in his gravitational studies of the 'General Three body problem': how a third, small body would orbit around two orbiting large ones.

Moon's L2. Since this is a gravitational well, minimal power will be required to keep it in place. This station can support a small astronaut crew and function as a staging area for future missions to the outer planets.

L4, L5: Clusters

Both the L4 and L5 points are functionally the same. The L4 and L5 points are often the sites of gigantic space colonies in science fiction, such as Hollowed Asteroids or Bernal Spheres or O'Neill Colonies. This is because they offer stability, and an object at or orbiting one of these points can stay in that position indefinitely.

In 1956, the Polish astronomer Kordylewski discovered large concentrations of dust at the Trojan points of the Earth-Moon system. For large space structure whose course corrections in other orbits would require large expenditures of fuel and energy, this is a very attractive option.

Solar power satellites can also be advantageously positioned at L4 or L5. As an orbital infrastructure grows, numerous structures including colonies, stations, and automated satellites would likely be seen circling these Lagrange points in halo orbits.

In other words, in the Earth-Moon system, an object in a Lagrange point will keep pace with the Moon in its orbit about Earth. The third particle can rotate at a constant relative speed with respect to the two bodies if placed at one of the Lagrangian points.

Sun-Earth Lagrange Points in Space Exploration

Similar to the Earth-Moon system, the Lagrange points of the Sun-Earth system also provide several incentives to aid space explorations.

L1 is a very good position for monitoring the Sun. The solar wind reaches it about one hour before reaching Earth. In 1978, the International Sun-Earth Explorer-3 (ISEE-3) was launched towards L1, where it conducted such observations for several years.

Now the ESA/NASA SOHO (Solar and Heliospheric Observatory spacecraft) solar watchdog is positioned there. Launched in 1995, SOHO was designed by NASA and the European Space Agency to study the Sun's effects on the Earth. The SOHO follows a "halo" orbit around Earth's L1, which is 1.53 x 106 km from Earth. From there it has an uninterrupted view of its target the Sun, and its orbital excursions ensure that ground stations are not always pointing right at the noisy Sun for communications.

The Wilkinson Microwave Anisotropy Probe (WMAP) spacecraft resides in a halo orbit near Earth's L2 (about the same distance from Earth as L1), which is about 1.5 million km from the Earth. It enjoys an uninterrupted view into deep space from L2 location. Its six-month orbit about L2 prevents the Earth's shadow from ever blocking the craft's solar arrays.

By collecting microwave radiation from over 13 billion light years away, scientists have been able to precisely determine the age of the universe and its components, and produce substantial evidence supporting the Big Bang theory. The forces acting on WMAP at L2 tend to keep the spacecraft aligned on the Sun-Earth axis, but require course correction to keep from moving toward or away from the Earth.

ESA (European Space Agency) has a number of missions that will make use of this spot in the coming years. L2 will become home to ESA missions such as Herschel, Gaia and the James Webb Space Telescope (JWST). JWST is scheduled to take off in 2018 to look at the first galaxies that formed in the early Universe, connecting the Big Bang to our own Milky Way Galaxy.

Planck, launched in 2009, is the first European mission to study the birth of the Universe. It currently orbits in a Lissajous curve about the second Lagrange point of the Earth-Sun system (L2), with average amplitude of about 400,000 km.

Since the position of L3 lies behind the Sun, any object that may be orbiting there cannot be seen from Earth. As of now, no satellite or observatory is planned to position at Sun-Earth L3.

In 2010, NASA's Wide-field Infrared Survey Explorer (WISE) telescope finally confirmed the first Trojan asteroid, called 2010 TK7, around Earth's leading L4. The asteroid is roughly 1,000 feet (300 meters) in diameter. The Sun's pull causes any object in the L4 and L5 locations to 'orbit' the Lagrange point in an 89-day cycle.

STEREO (Solar TErrestrial RElations Observatory), launched in 2006 by NASA, consists of two space-based observatories – one ahead of Earth in its orbit (L4), the other trailing behind (L5). With this new pair of viewpoints, scientists will be able to see the structure and evolution of solar storms as they blast from the Sun and move out through space.

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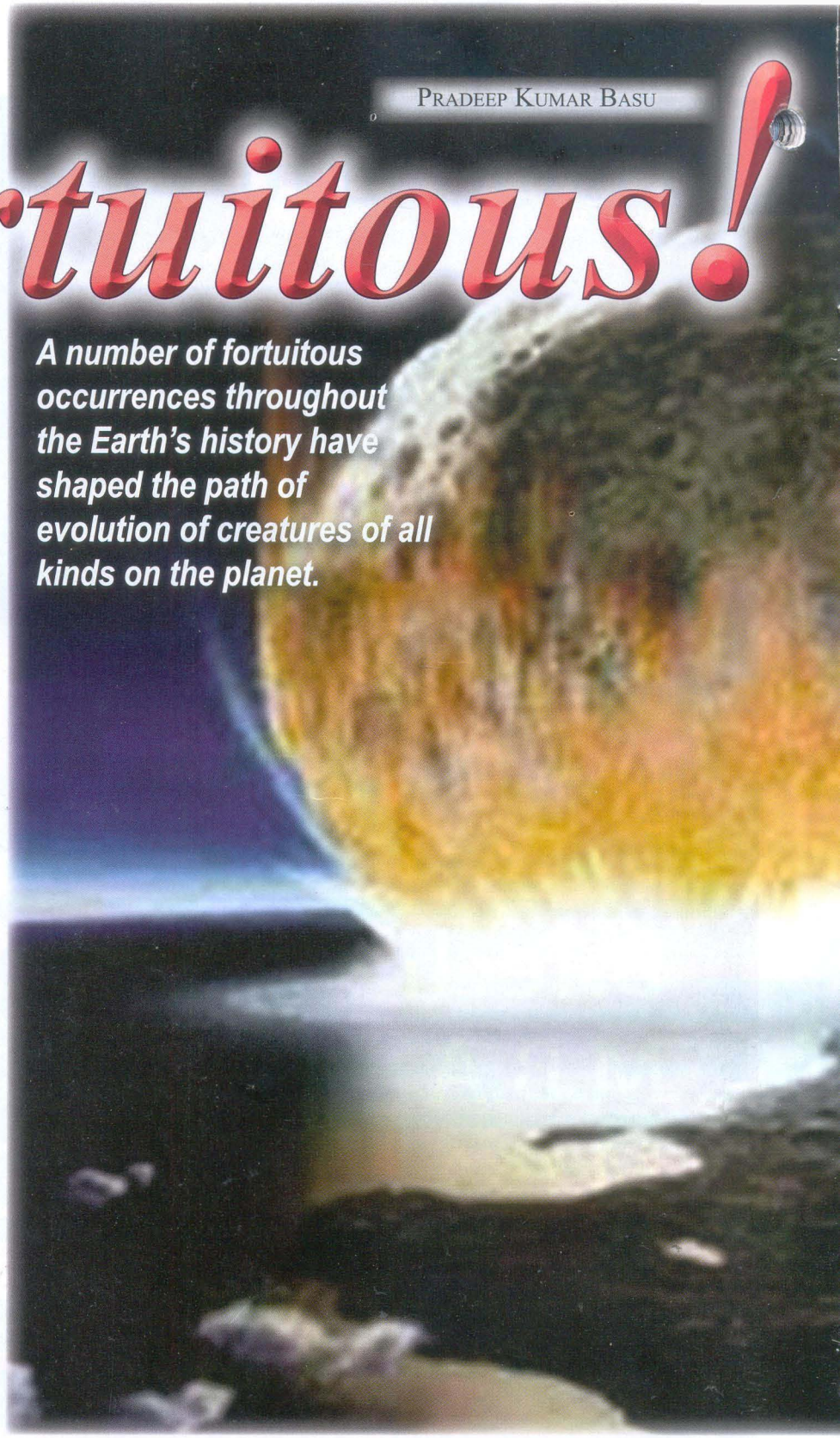
PRADEEP KUMAR BASU

Fortuitous!

A number of fortuitous occurrences throughout the Earth's history have shaped the path of evolution of creatures of all kinds on the planet.



SOME of you may recall the excitement with which the whole world, especially the astronomy community, was gazing at the planet Jupiter on 16 July 1994. Fragments of the comet Shoemaker-Levy 9 were expected to crash into Jupiter – the first time such a scene was being witnessed from Earth.

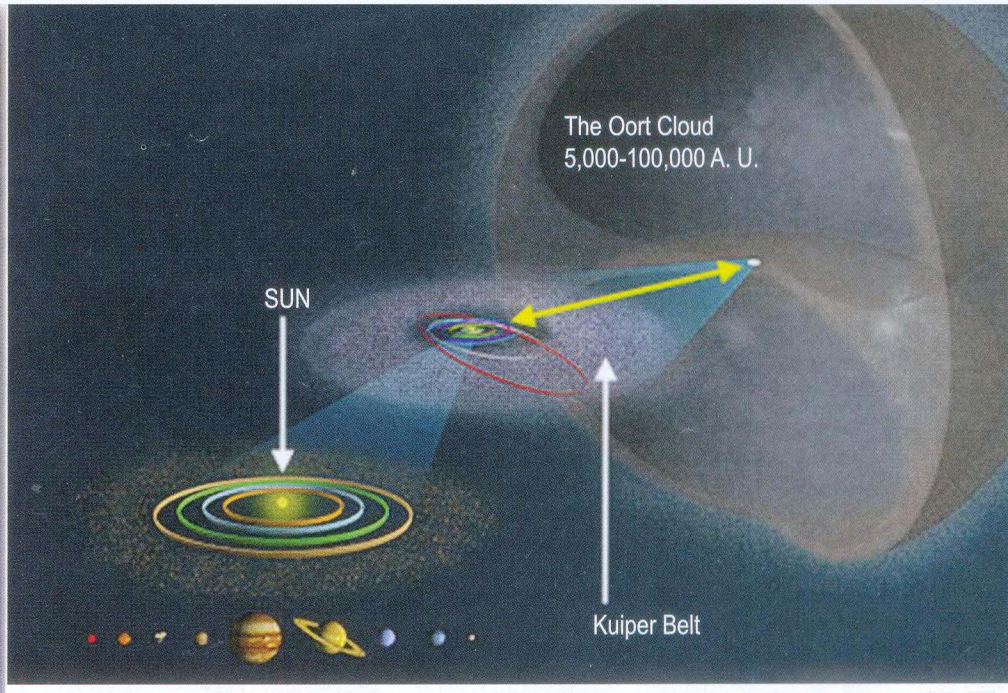
The typical Jovian cloud top temperature is about 130 K. Instruments on the Galileo spacecraft detected a fireball which reached a peak temperature of about 24,000 K, before expanding and cooling rapidly to about 1500 K after 40 seconds. The plume from the fireball quickly reached a height of over 3,000 km. For the first time, data about Jupiter's composition below the clouds could be gleaned from the spectroscopic data. Diatomic Sulpur, Sulphur Dioxide, Ammonia and Hydrogen Sulphide were detected.

These astronomical mavericks come from two sources. One is a belt of asteroids between the orbits of the Earth and Mars. Sometimes one or two asteroids leave the belt and some of them may collide with other planets in the solar system. The other are comets, which come from a huge belt of them outside the solar system called the Oort cloud. It is named after Dutch astronomer Jan Hendrik Oort (1900-1992) who postulated in 1950 a spherical cloud of icy planetesimals roughly 1 light year (9.46 x 1012 km) from the Sun. Its outer limit defines the outer edge of our Sun's gravitational dominance.

Recently, astronomers were closely watching the fate of Comet ISON which was approaching the sun. However, contrary to expectations it fizzled out.

Obviously, our Earth has been hit from time to time by meteorites of different sizes. Most of the damages caused by the smaller ones have been removed by the Earth's continuous process of erosion. But some big ones have left their permanent mark. One of them even changed Earth's flora and fauna and was responsible for the rise of the mammals including us.

Before we come to that, let us make a brief mention of a meteor crater in our country – the Lonar Lake in Buldana district of Maharashtra. The lake has a

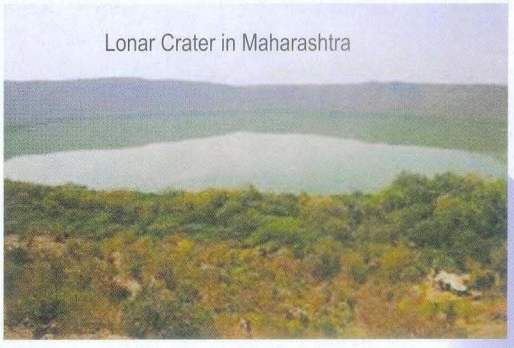


These astronomical mavericks come from two sources. One is a belt of asteroids between the orbits of the Earth and Mars. Sometimes one or two asteroids leave the belt and some of them may collide with other planets in the solar system.

If you could time travel back 65 million years in Earth's history, you would initially be bewildered. Most of the plants, trees and animals would look strange to you. Majority of them have no modern counterpart. You would be lost till a huge creature passed by leisurely in front of you. Its head is two storied high, followed by a huge body and a long tail. An elephant would look puny in front of it.

Thanks to the movie *Jurassic Park*, you would recognize it to be a dinosaur. Yes, it was the age of the dinosaurs who had entered the scene 237 million years ago (mya) and were the current dominant species. If you are a careful observer, you would also see a small shrew-like animal darting out of a hole in a tree, very nervously picking up some fruits and berries and rushing in again to its safe haven. You would feel pity for it.

But an event was going to happen soon which would completely change the scenario. That small creature's descendants, you among them, would rule the world 65 mya hence. That fortuitous occasion is the Earth being hit by a meteor of around 10-15 km diameter releasing energy of 100 teratonnes of TNT, billion times the energy released by the Hiroshima and Nagasaki atom bombs. The meteor hit the Earth at the Yucatan Peninsula, at Chicxulub, Mexico. The impact crater is buried under the Yucatan peninsula. Radar images show the diameter to be 180 km, the largest impact crater on Earth. Its centre is below the town of Chicxulub.


Lonar Crater in Maharashtra

The hypothesis that this impact caused the extinction of 75% of the species of the time including all non-avian dinosaurs was proposed by the renowned American Nobel Laureate physicist Louis Alvarez (1911-1988) in collaboration with his geologist son Walter in 1980. In collaboration with chemists Frank Asaro and Helen Michels, they discovered that sedimentary layers found all over the world of that time contain a concentration of Iridium hundreds of times greater than normal. Iridium is extremely rare in the Earth's crust because it is very dense, and therefore most of it sank into the Earth's core while the Earth was still molten. It therefore must have come from the meteorite.

diameter of 1.2 km and is about 137 m below the crater rim. The meteor crater rim is about 1.8 km in diameter. The water is both saline and alkaline. Radioactive dating gives the age of the lake has having formed around 570,000 years ago.

An impact crater

An immediate consequence of the impact would be that millions of tonnes of rock would have been ejected into space on ballistic trajectories. Reheated by atmospheric re-entry, this debris would have superheated the air across the entire planet, putting the world's forests on fire. Shockwaves would have radiated outward from the impact site, inducing Earthquakes and volcanoes along their path. Mega tsunamis would have followed, pounding coastlines around the world.

The dust clouds covering the sky, blocking out the sun, would prevent photosynthesis for some years. It has also been estimated that sulphuric acid aerosols would also be injected into the atmosphere leading to 10-20% reduction of transmission of sun rays. So a large number of plants and phytoplankton and therefore all animals dependent on them would become extinct. All these together would have led to a mass extinction of large animals and plants in particular. Obviously the dinosaurs were wiped out. Only avian dinosaurs have survived in their descendants, the birds.

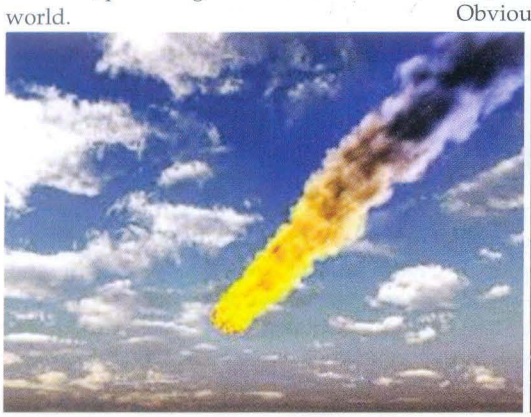
If you are wondering as to how a meteor of 10-15 km diameter can cause such devastation to the mighty Earth with its diameter of 12,756 km, let me give an example from more recent times. In 1883, there were four explosions of the Krakatoa Volcano Islands located between Sumatra and Java in Indonesia. They caused massive tsunamis which killed an estimated 36,000-100,000 people. The sound was heard from as far as 3000 km.

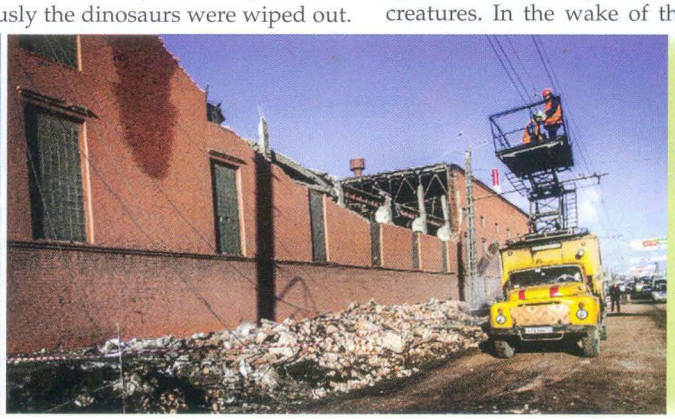
The shock wave went round the globe seven times. The average global temperature fell by 1.2 degree C. The weather patterns continued to be chaotic and did not return to normal till 1888! The energy released has been estimated to be between 200-240 megatons of TNT, peanuts compared to the Chicxulub asteroid crash. The main cause of the devastation is the kinetic energy packed in the blow.

The evidence for the Alvarez impact hypothesis is supported by chondritic meteorites (low iron and nickel content) and asteroids which contain a much higher iridium concentration than the Earth's crust. The isotopic ratio of iridium in asteroids is similar to that of the rocks' boundary layer of the time, but significantly different from the ratio in the Earth's crust.

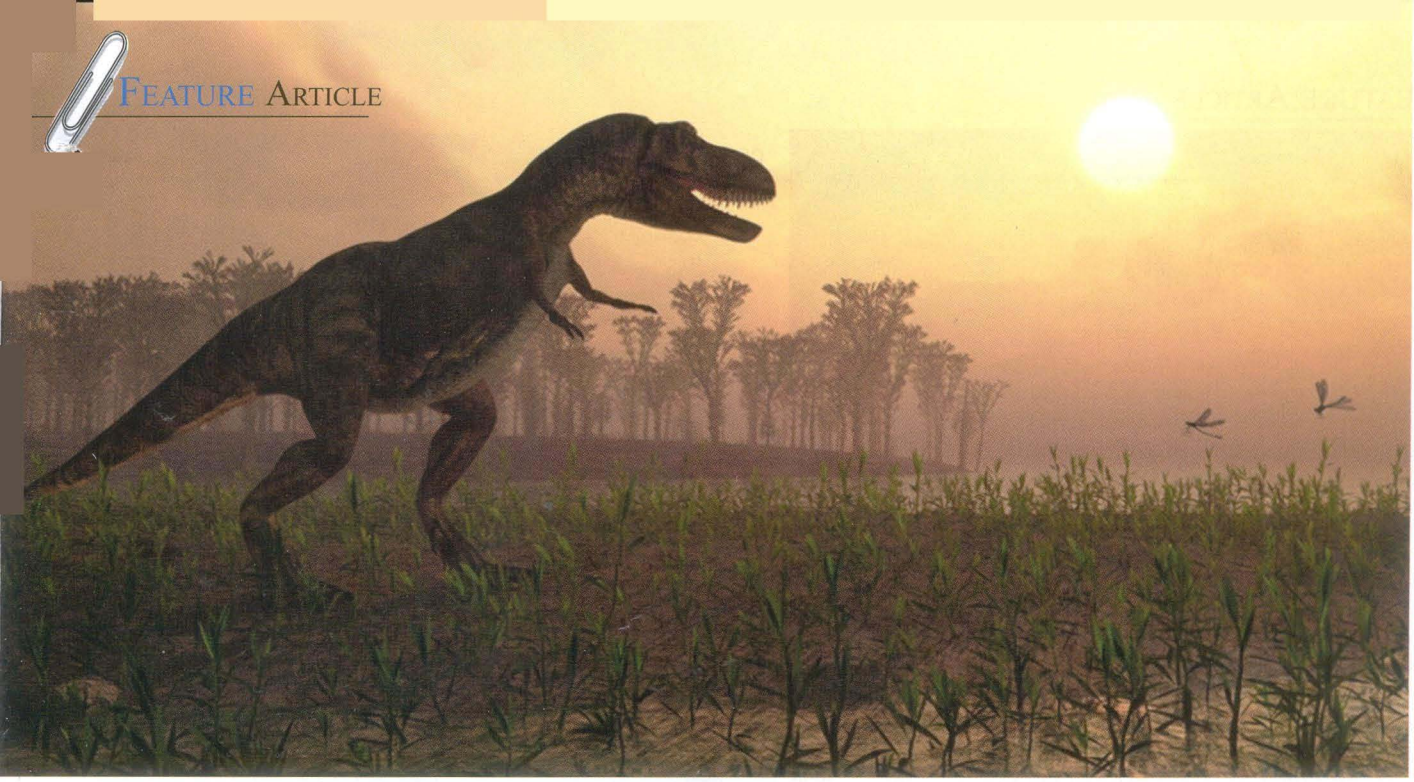
Geologists Allan O. Kelly and Frank Dachille in a 1953 publication analyzed geological evidence from around the Earth and concluded that one or more giant asteroids impacted the Earth, causing an angular shift in the Earth's axis, global floods, fire, atmospheric occlusion, thus supporting the Alvarez hypothesis.

Yet the devastation caused by the extinction also provided evolutionary opportunities, especially to small creatures. In the wake of the extinction,





A meteor exploded over Chelyabinsk in Russia unleashing extensive damage



many groups underwent remarkable changes – a sudden and prolific divergence into new forms and species. Mammals in particular diversified producing new forms such as horses, whales, bats, and primates. And of course we are there at the end of the chain of primates! A number of new species of fish, birds, and snakes also came into being.

In March 2010, an international panel of scientists endorsed the asteroid hypothesis, specifically the Chicxulub impact, being the cause of the extinction. A team of 41 scientists reviewed 20 years of scientific literature and in so doing also ruled out other theories such as massive volcanism.

A very fortuitous event in the Earth's history thus gave us the opportunity to occupy the centre stage!

But it was not easy. We diverged from the chimpanzees' 6-8 mya. Then after half a dozen branchings, it is believed that our species, the *Homo sapiens* arose throughout Africa around 200,000 years ago. But around 195,000 years ago disaster struck. The planet entered a long glacial stage called Marine Isotope Stage 6 (MIS6) that lasted until 123,000 years ago. Much of the landmass would have become inhabitable. Deserts would have spread. Genetic studies have shown that the human population plummeted from greater than 10,000 to just hundreds. The future of our species was in peril.

By design or luck one group went to the southern coast of Africa. There they found an abundance of shellfish and edible plants. Excavations in this region have recovered artifacts left behind by that pioneer population. They took shelter in caves in hills very near the coast, which allowed easy access to shell fish at low tide. The caves were at sufficient height to protect them at high tide. Once the climate changed for the better, *Homo sapiens* bounced back and were very soon colonizing the whole world.

While on the topic, let me touch on two other extinctions which also affected Earth's flora and fauna.

The Permian period (298±.02 to 252±5 mya) in Earth's history also ended with a mass extinction in which 90% of marine and 70% of land life was destroyed. It had been suspected that a meteor strike was the cause. A crater Araguainhua straddling the states of Moto Grosso and Goias of Brazil was suspected to be the cause. Its diameter is 40 km.

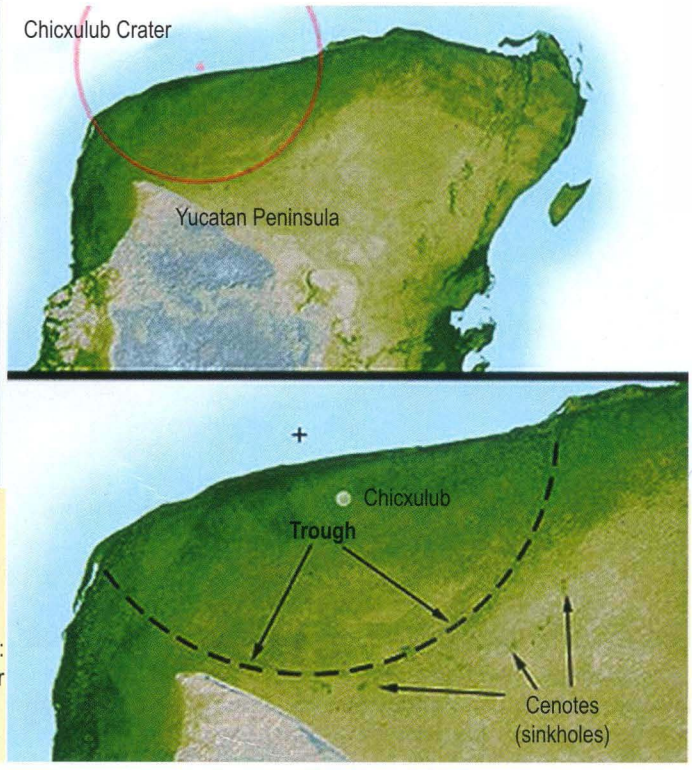
Recently, a team led by Dr. Tohver of University of Western Australia has dated the crater to be 254.7 ± 2.5 mya which fits the time frame. The crater is an area where a sizable number of rocks are oil shale. It is postulated that earthquakes of 9.9 magnitudes would have released a lot of oil and gas causing firestorms, which would have directly killed. Also methane in the atmosphere would have caused a global rise in temperature leading to the disappearance of many species.

At the moment, 189 impact craters are known all over the world. More are likely to be discovered. On impact, the temperatures shoot a few thousands degree high. Earlier simulation has shown the temperatures come down to surrounding values in around 10,000 years.

But recently, a team of Martin Schmeider and Fred Jourdan from the University of Western Australia, studying the 76 million years old, 23-km diameter Lappajarvi crater in Finland using argon-argon dating – radioactive decay of potassium to argon – found the time period to be several hundred thousands of years, perhaps more than a million years. The scientists postulate that the impact craters, which were more numerous in the beginning of Earth's history, could have served as hydrothermal areas for primitive life to develop. It is as if the impacts created large number of petri dishes all over the world for the experiment of life!

The giant woolly mammoth became extinct around 13,000 years ago. A group at University of Cincinnati's Quaternary and Anthropocene Research Group (QARG), headed by Kenneth Tankersley, has postulated that the extinction is also linked with some asteroid passing very close to Earth. His conclusions are based on geological studies done at Sheridan Cave in Wyandot County, Ohio.

It is in that spot, 100 feet below the surface, where Tankersley has been studying geological layers that date to the Younger Dryas time period (12,800-



Above: Brown spots are impact sites on Jupiter

Right: Chicxulub crater

11,500 years ago). About 12,000 years ago, before the Younger Dryas, the Earth was at the Last Glacial Maximum – the peak of the Ice Age. Millennia passed, and the climate began to warm. Then something happened that caused temperatures to suddenly reverse course, bringing about a century's worth of near-glacial climate that marked the start of the geologically brief Younger Dryas. There are only about 20 archaeological sites in the world that date to this time period and only 12 in the United States – including Sheridan Cave.

Tankersley found ample evidence to support the theory that something came close enough to Earth to melt rocks. Among the foremost findings are carbon spherules. These tiny bits of carbon are formed when substances are burned at very high temperatures. The spherules exhibit characteristics that indicate their origin, whether from burning coal, lightning strikes, forest fires or something more extreme.

Tankersley says the ones in his study could only have been formed from the combustion of rock. The spherules also were found at 17 other sites across four continents – an estimated 10 million metric tons worth – further supporting the idea that whatever changed Earth did so on a massive scale. It is unlikely that a wildfire or thunderstorm could cover about 50 million square kilometers.

The side effects of the incident would have been toxic gases in the atmosphere clouding the sky causing temperatures to plummet. As in the earlier case of the Chicxulub strike, it is the bigger animals who become the first victims of the calamity. Man at that time was living a hunter-gatherer life. He was intelligent enough to probably survive by moving to warmer regions though some scientists postulate that the Clovis people of North America became extinct at this time.

Evidence from the Sheridan cave shows 68 out of 70 species there survived. Two species, the giant beaver and the flat-headed peccary, a sharp-toothed pig the size of a black bear, disappeared. All this within a man's lifetime!

More recently, on 15 February 2012, a bolide (a meteor shining with a particular luminosity) exploded over Chelyabinsk in Russia. Scientists have calculated that it burnt at a height of 30 km. It was of 20 meter in diameter, weighed 7,000-10,000 tonnes and was traveling at 64,000 kph. About 7200 buildings were damaged and 1491 people injured. Luckily there were no deaths.

The infra-sound sensors in place for detecting nuclear explosions showed that the shock wave traveled twice around the globe. The energy of the blast has been calculated to be between 300-450 kilotons. In 1908, a similar meteorite burst of estimated 10-15 megaton intensity over Tunguska in Russia flattened over 2000 sq km of Siberian forests.

All these incidences in the Earth's history remind us how fragile our existence is. Either of these incidences could happen any time in the future. If it is not calamitous, humans with their advances in technology would probably survive, but the Earth would be a changed place.

Today, a large number of telescopes, both ground and space based are routinely scanning the sky. A group of scientists keep a close watch on the trajectories of asteroids likely to be on a collision course with Earth. Scientists are busy debating on methods to either divert the course or destroy any asteroid headed on a collision course with Earth. On the latest count, 10,000 asteroids are under observation.

There is even a NEOShield space project funded by European Union with scientists from France, Germany, Spain, UK, USA and Russia working out ways of protecting the Earth from asteroids that come too near us. One of the plans is to try to deflect an asteroid in mid-2015. NASA has called for suggestions on how to deflect asteroids and also how to explore their resources. Out of 400 suggestions received, 96 have been short listed for in depth study.

Hopefully science will save us.

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SANJEEV KALITA

Is our Universe Shrinking or Expanding?

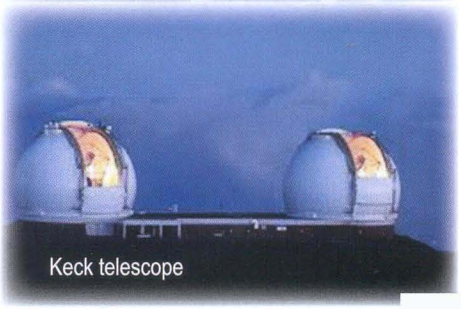
The currently less understood concepts of dark matter and dark energy will help answer this question. What are the possibilities?

ONE of the key questions in cosmology is whether the universe is closed or open. In more layman's terms – will it expand forever or will it halt its expansion and fall back? This has been the greatest cosmological conundrum since the advent of the Big Bang paradigm in the twentieth century, according to which our universe originated in a cataclysmic explosion of space-time.

The recent marvels in observational astronomy like the Hubble Space Telescope and ground-based Keck telescope have made the nature of our expanding universe comprehensible.

The answer to the question whether the universal expansion will continue ad infinitum depends upon the matter-energy content of the universe. The relation between matter-energy and the dynamics of expansion is expressed by certain sets of mathematical equations in Einstein's general theory of relativity.

Based on the assumption that in the large scale, the universe is homogeneous and isotropic, the Russian mathematician Alexander Friedmann calculated how fast the universe can expand with a given source of matter-energy. In Friedmann's model, three fundamental solutions emerge. If the density of matter-energy is more than a critical value, the geometry of space is closed like that of a spherical surface and expansion of the universe will stop and all the galaxies will fall together



It is the future generations of sophisticated telescopes equipped with new generation of observing techniques that are expected to uncover the nature of dark energy. The existence of dark energy has revealed that at least our universe is perhaps not going to end up with a Big Crunch.

due to mutual gravity. The universe will die in a cataclysmic collapse called the Big Crunch. If the density is equal to the critical amount, the universe just manages to escape the collapse and the expansion continues slowly for eternity.

It is like a ball thrown vertically upward with just the escape velocity of 11.2 km/sec so that it can just overcome Earth's gravitational pull. It is called a flat universe because under this condition the geometry of space is exactly like a flat surface, which is called Euclidean geometry. If the density lies below the critical amount, the universe will rapidly go on expanding. Under this situation, the geometry of space is like that of a saddle of a horse and is called an open universe.

Friedmann models are valid only for the presence of pressure-less matter called dust. Since random velocities of the galaxies are small compared to the velocity of light, the pressure-less condition is a reasonable approximation in cosmology. Most of the visible matter in the universe is confined to the galaxies in the form of stars and interstellar gases and dust. Powerful telescopes have enabled astronomers to estimate mass of a typical galaxy.

Thus, observation of a number of galaxies per unit volume of space can be employed to estimate mass density of luminous matter. However, the luminous matter is found to contribute only about 0.3% of the critical density. Therefore, luminous matter in the form of galaxies in the observable universe can never stop the universe's expansion.

However, detailed studies of dynamics of galaxies and clusters of galaxies have indicated that there is appreciable amount of gravitating matter which is ten to hundred times that of luminous matter. This kind of matter never emits light but exerts only gravitational pull on galaxies. Studying the Coma cluster, which contains about 10,000 galaxies, Fritz Zwicky suggested that stability of the cluster requires additional gravitating matter which is not confined to the galaxies. The galaxies towards the outer periphery of the cluster move with such high rotational speed that in absence of extra matter, they would have evaporated away from the cluster.

In 1975, astronomers Vera Cooper Rubin and Kent Ford from America announced in the American Astronomical Society that rotational velocities of stars in spiral galaxies require additional matter. Instead of falling at large distance from the galactic centre, the rotation velocity of stars remains almost constant. This phenomenon, called a flat rotation curve, is possible only if the galaxies have almost ten to hundred times more matter which does not emit any light but has only gravitational effect. This type of matter is uniformly distributed beyond the visible dimension of a galaxy, called the halo.

It means that the matter of this type never loses energy by interaction with visible matter. This dissipation-less matter component which has additional gravitational influence is called dark matter. It has been dubbed as 'dark' not because we cannot see it but because the nature and composition have not yet been inferred from any experimental observation.

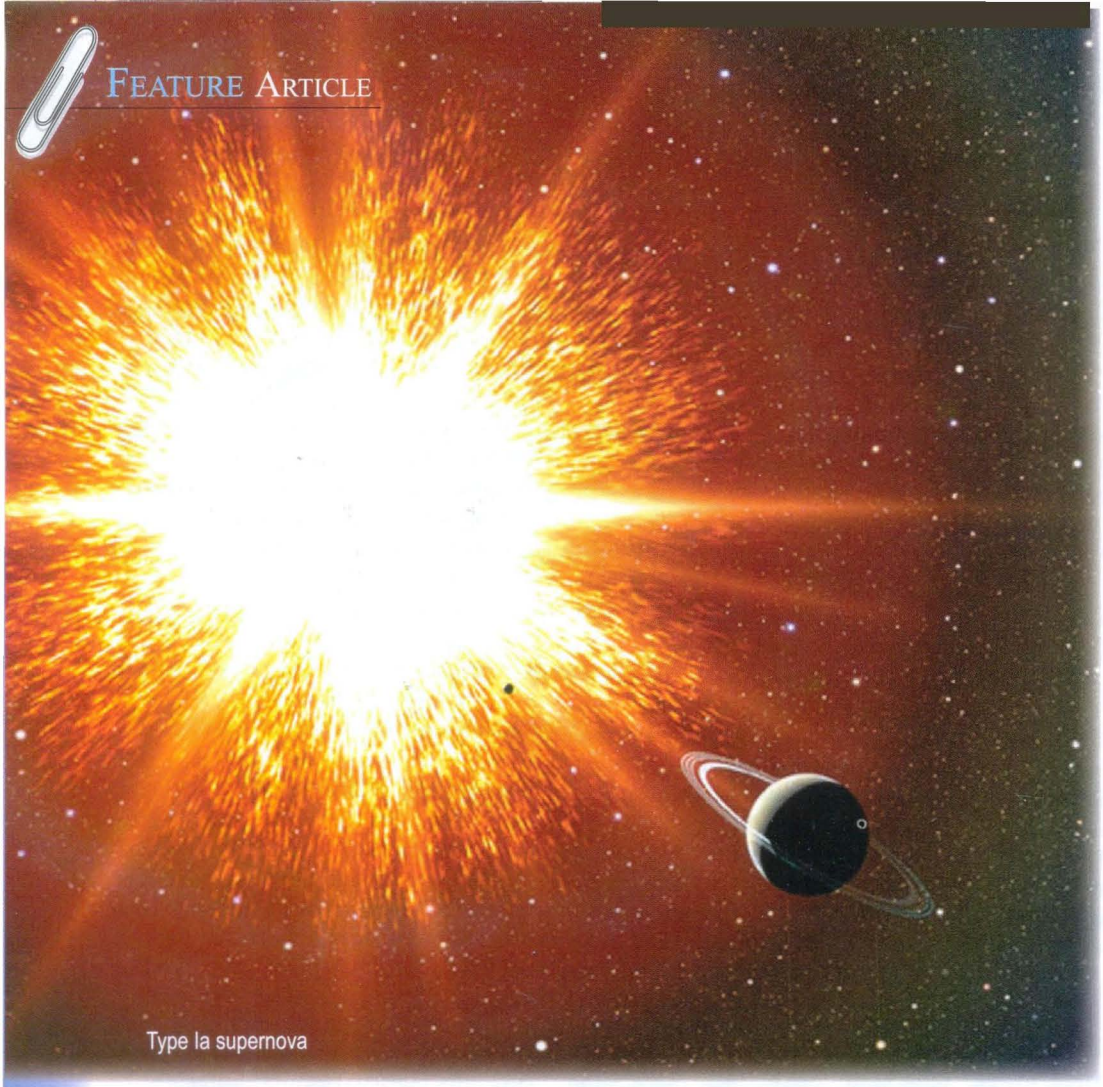
But it is true that dark matter contributes appreciably to the cosmic mass density. Astronomical observations in the last two decades of the 20th century and those performed by extremely precise space probes like Wilkinson Microwave Anisotropy Probe (WMAP) have uncovered that mass density of the visible and 'dark matter' contributes almost 30% to the critical density. Although it is not enough to stop the expansion of the universe, this kind of extra gravitating and non-dissipating matter has been found to be inevitable for providing with enough gravitational potential responsible for formation of gravitationally bound structures like galaxies and clusters.

Galaxies and clusters with dark matter were considered to be the only components of the universe contributing to gravity. On this basis, by the early nineties, cosmologists concluded about a low density universe, which favors the open Friedmann model.

However, Nature is extraordinarily rich in her diversity. Careful astronomical observations in the 1990s by Saul Perlmutter of Lawrence Berkeley National Laboratory in America and Brian Schmidt of Mount Stromolo and Siding Spring Observatories in Australia, rocked our understanding of cosmology. The expansion of the universe was found to be speeding up under the influence of a mysterious antigravity, called dark energy, embedded in space itself.

They used certain types of exploding stars called Type Ia supernova for the determination of expansion rate of the universe. This kind of supernova originates in a white dwarf -- a burnt-out star with size that of the Earth which is fading and cooling. If a white dwarf

For observational astronomers, it is still difficult to distinguish between cosmological constant, quintessence and phantom.



Type Ia supernova

If the density of matter-energy is more than a critical value, the geometry of space is closed like that of a spherical surface and expansion of the universe will stop and all the galaxies will fall together due to mutual gravity.

Detailed studies of dynamics of galaxies and clusters of galaxies have indicated that there is appreciable amount of gravitating matter which is ten to hundred times that of luminous matter.

has a companion star, its intense gravity sucks matter from the companion. When its mass exceeds the critical limit, about 1.4 times that of the mass of the Sun, the white dwarf explodes in a fury as bright as billions of Suns.

Because all the Type Ia supernovae originate at the same physical environment, their intrinsic luminosity (amount of light energy emitted per unit time) is the same. Thus just by determining how bright they appear in a telescope, it is possible to determine their distances accurately.

Astronomers found that the supernovae appear to be fainter than expected in an open Friedmann model. The inference is drawn that the space itself is inflating at exponential fashion due to a repulsive gravity which constitutes an energy density of about 70% of the critical density.

But what this repulsion in gravity? It is not a surprise for general theory of relativity. Einstein, in 1917, theorized the presence of such a cosmic repulsion known as the cosmological constant in his gravitational field equations to construct a static cosmological model. He had withdrawn the cosmological constant from his theory, once the expansion of the universe was discovered by American astronomer, Edwin Powel Hubble. Friedmann showed that a homogeneous and isotropic space can have expansion without the 'cosmological constant'.

However, Willem de Sitter, the Dutch mathematician and astronomer, showed that cosmological constant is the inertia of empty space. de Sitter's solution in general relativity shows that space gets an innate tendency to expand due to presence of cosmological constant or cosmic repulsion.

In 1967, Soviet physicist Yakov Borisovich Zel'dovich pointed out that a cosmological constant in empty space is exactly equivalent to energy density of quantum vacuum. In modern theories of particle physics, a 'quantum vacuum' is not emptiness of space or state of nothingness; rather it is a foam of fluctuating particles and anti-particles. It contributes an energy density which is gravitationally repulsive in nature. Such repulsion manifests due to negative pressure.

The ratio of pressure to energy density of vacuum is one. It means that as space expands, more energy appears and it in turn fuels the expansion. The repulsion originates in space itself. As the universe expands and creates more space, the "push" from the cosmological constant rises steeply and the universe grows exponentially, shooting the galaxies faster.

The 'cosmological constant' has now been considered as a potential candidate of 'dark energy'. The energy density of dark energy is almost twice that of 'dark matter', indicating that currently the universe is undergoing an accelerated expansion. The effect of dark energy was negligible in the past history of the universe because the density of matter was huge and the universe was smaller

If the density is equal to the critical amount, the universe just manages to escape the collapse and the expansion continues slowly for eternity.

as predicted by the Big Bang scenario. However, as the universe becomes more dilute due to recession of galaxies, empty space comes to dominate and hence dark energy plays a role to inflate the expansion of the universe.

Within a decade since its discovery in 1998-99, hundreds of scientific papers have been published on its observational as well as theoretical descriptions. The exact physical origin of this mysterious dark energy is yet to be explained. Observational confirmation of an accelerating universe has brought Nobel Prize in physics in 2011 to Saul Perlmutter, Brian Schmidt and Adam Guy Riess of Johns Hopkins University, who performed remarkable astronomical observations that have shaken the long standing astronomical orthodox of a matter-dominated Friedmann universe.

Parallel to general relativity, quantum physicists have proposed several candidate sources for dark energy. In some models, dark energy is a scalar field hidden in space which has pressure to density ratio between -1/3 and -1. A scalar field is certain field strength in space represented by a scalar quantity. Such scalar fields are called quintessence by cosmologists.

Quintessence will make the universe expand exponentially in the distant future and most of the galaxies will not be visible. The universe will become cool and dark. In certain scenarios, such scalar fields can have pressure to density ratio less than -1. In this situation, it is called a phantom. In the presence of phantom the repulsive gravity becomes so strong that in the long run it will break the galaxies apart and not only that, the repulsive gravity will rapidly become infinite and every atom of the universe will be torn apart. Such a catastrophic end of the universe is called Big Rip.

For observational astronomers, it is still difficult to distinguish between cosmological constant, quintessence and phantom. Some cosmologists believe that dark energy is not any kind of strange energy but it is the influence of large scale modification of Einstein's general relativity.

Leading candidates of string theories provide the idea of extra dimensions. String theorists believe that accelerated expansion of the universe is the result of weakening of gravity in the large scale due to leakage of universal gravity from four-dimensional space-time to hidden dimensions of space.

However, it is the future generations of sophisticated telescopes equipped with new generation of observing techniques that are expected to uncover the nature of dark energy. The existence of dark energy has revealed that at least our universe is perhaps not going to end up with a Big Crunch, rather it will be emptied by exponentially expanding space. The fate of the universe seems to be cold and dark.

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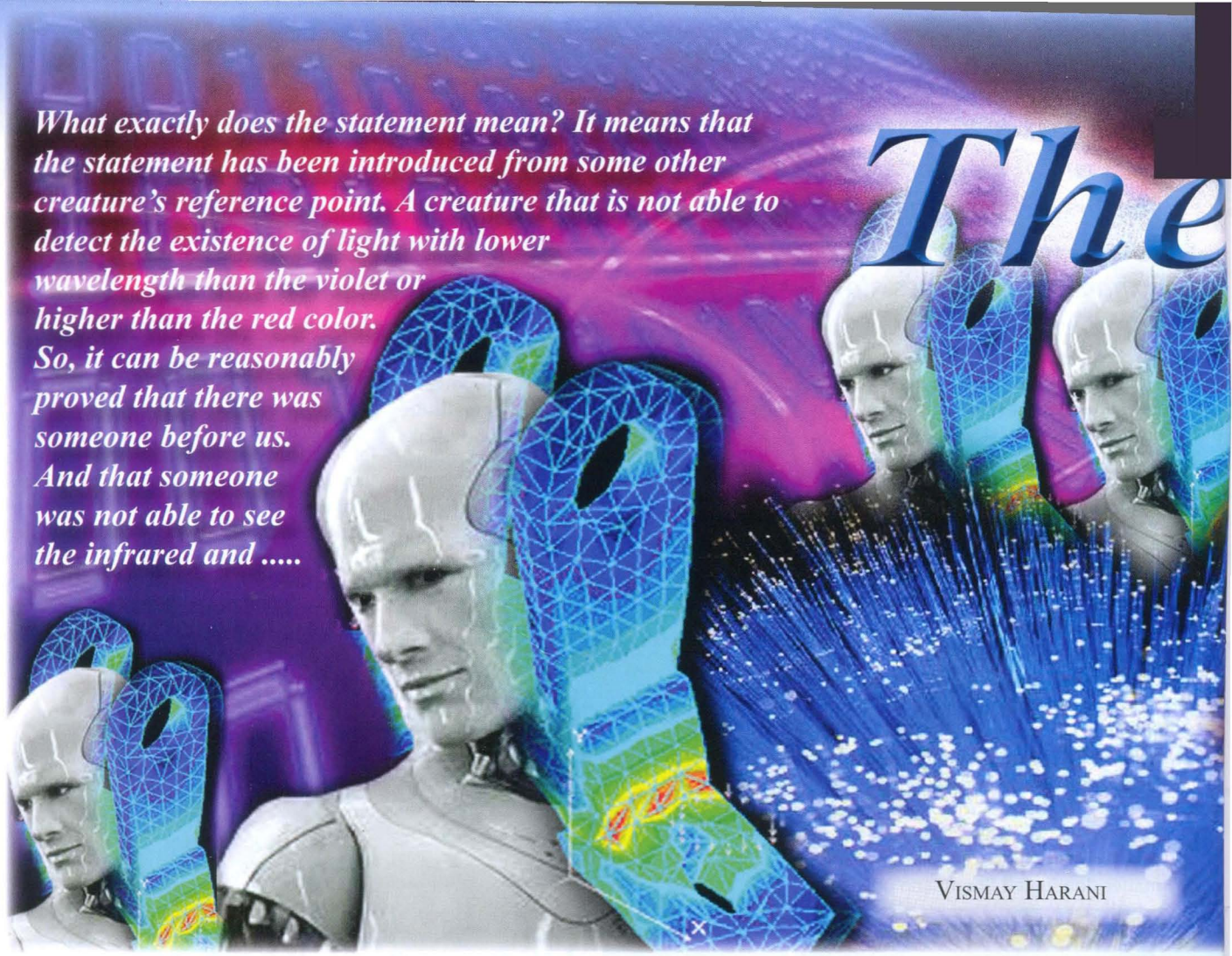

Date: 12-03-3045

Subject: CLDR-234

Classification: Unknown

Description: Subject is responding to external stimuli. It is characterized by high level of neural activity. High Brain Body Ratio. No apparent arsenal to hunt.

Food: It is in infantile stage. It can be taught to eat any type of food. Based on the initial conditions, probability of its being an herbivore is 85%.

Assistance: Constant surveillance required. Unable to carry out daily activities on its own.

Resource Consumption: Maximum

Conclusion: High Potential

Recording process initialized. This is Robot 3456 TQ, specially equipped with thought processor aiding in sentence framing, syntax control and Nursing abilities. This is my 1245th day with the subject.

Subject is still switched off. Subject is quite erratic in his power saving operations. He switches on at 9:45 pre-processed time + 2 hours. Through constant monitoring of his genetic traits and exterior atmospheric conditions, subject is found to follow his own natural clock of powering on and off. Now, based on the safe bearing limit, it is time to prepare fuel for the subject. If a robot shows inaccuracy in delivering the subject its power, it habitually enters into the phase of vocal straining and solvent shedding. Quiet soothing pattern forming noise pulses calms down its heartbeats.

Subject prefers shrill and soft voice, which naturally indicates that subject is more inclined towards its mother (mother-manifest) than the high wavelength voice of father. Subject is showing full-fledged growth of teeth, and it is advised to move from fluid to solid phase of food. Subject also shows preferences to different type of food products, though it is not entirely rational in that operation. It sometimes rejects the high nutrition food, showing distaste. The subject likes fatty foods, though it is not good for his survival.

Subject does not naturally follow his instincts unlike other carbon-based life forms. It has an ability to doubt (possible thought process?).

Click. Click.

Subject has now entered into the phase of vocal straining and solvent shedding.

The mash has been carefully prepared which includes variety of stimulants, suppressants, vitamins, proteins, and a healthy amount of starch in a suitable saliva soluble solvent. The operator at job has to find randomly processed but varied (creative)

Lost Race

solutions in order to make subject digest the useful content for his survival.

Now Nurse 44423 LSE along with the help of DISTRACTOR 45-Prototype is feeding the subject. DISTRACTOR, as it has been recorded in previous routine videos is a specialized robot tailor-made to suit the fancy of this young creature. It's purpose is to produce a plethora of different sounds, some ticklish, some soothing, others quite entertaining so as to keep the infantile engrossed while the other nurse performs the task of feeding the growing infantile. This technique has been developed by trial and error with approximate understanding of its genes.

No anomaly has been detected in the internal structuring of this young something except for a bulging tumor at the base of his stomach. It was due to negligent dosage of one of the specific suppressants to keep in check the growing stem cells. The error has been rectified.

As of now, 11:20 A.M. Greenwich Time, the subject is well fed, sterilized, it has performed the excretory process normally, the excreta does not reek with disease as feared, pardon my phraseology. The bacteria introduced in the subject's gut have proved beneficial to the subject's digestive system, indicating the possibility of mutual win-win scenario between host-parasite relationships. The Processor-Head of this project has given a go-ahead to the research department to test several such permutations on inferior animate objects to see the extent of this relationship. As of now, the texts stored in the ancient Computer Brains have proved extremely beneficial in shaping this creature. It should also be noted that no other organism is as extensively researched and well catalogued in the ancient computer journals as this one is. This creature might most probably be 'the chosen one'.

My services are rendered for today. I will be replaced by another nurse of the same breed as of me.

Shutting operation begins.

The Life and Times of Robots

By R2T2 Supercomputer

Continuing from 47 kb

...it still is the greatest mystery of our time. Radioactive carbon dating has shown that robots have existed for millions of years. But only in the last few ten thousand years has it shown remarkable feats of advancements in various fields. Variety of creatures existed before the robots – the dolphins, elephants, dinosaurs and the so alleged 'the chosen ones' – whose classification is still not known. Though we have gathered massive amount of data from the ancient computers about these pre-iron life, yet the hunt for its origin is on.

'The chosen ones' have found a place in popular myths and in different holographic movies, yet the key to this 'ultimate puzzle' remains elusive. As such, no consensus has been reached between the different arguments that have been put forth by various religious sects but it is found that all the religions point to a common species of God, whom they call 'the chosen ones'.

Before going further, I would specifically like to emphasize a point here. We have studied during our Elementary Education Gathering Process that each computer inherently follows two languages – Binary and English. Binary language happens to be mother of all languages without which our survival is not possible. Yet our command language remains English. There happens to be a binary code for each letter of English alphabet, its syntax and the numeric system, group of words, and paragraphs. The ancient computers are detected to have been inundated with this English jargon which we don't actually need. For example, in the study of spectrum of light we have come across three bands, namely, ultraviolet, visible and infrared. Now, going by the so-called definition stored in the prehistoric computers, 'infrared and ultraviolet radiations are something which we cannot actually see through naked eyes'.

But we have no difficulty in detecting lasers; for God's sake, we operate due to its presence. So what exactly does the statement mean? It means that the statement has been introduced from some other creature's reference point. A creature that is not able to detect the existence of light with lower wavelength than the violet or higher than the red color. So, it can be reasonably proved that there was someone before us. And that someone was not able to see the infrared and ultraviolet radiation. This English-speaking species is considered to be 'the chosen one'.

Romantics go as far as to say that we were created by them (The belief of mutual existence of two superior intelligent civilizations is called Romanticism). They believe that the fact that the Age of Computers coincides with the 'age of the chosen ones' proves that we originated at the time when these carbon-form alpha animals dominated the Earth. This sect even believes that both of them depended on each other for their survival; they live peacefully, in mutual co-operation, and there happened to be no apparent clash between them.

Though hardly believable, what these arguments actually point to, is that the chosen ones' language was English which is believed, they passed on to us just as we passed on to them our arithmetic, graphical and machinery-control services. In the course of time, machines outdid 'the chosen ones', which eventually led to their demise.

But today we have a dire need of them...

Vismay Harani, 304, Shreeji Apt, 28 Kadamnagar, Nizampura, Vadodara-390024; Email: harrypottervegetarian@gmail.com

Human Reproduction

ANJUM FATIMA

1. The male hormone testosterone is produced by:
a) Leydig cells b) Somniferous cells
c) Epididymis d) Vas deferens

2. Male gonads are called:
a) Testes b) Blastocyst
c) Ovaries d) Scrotal sacs

3. The fertilized egg is called:
a) Ovum b) Diploid cell
c) Sperm d) Zygote

4. The ultimate stoppage of menstrual cycle is called:
a) Puberty b) Menarche
c) Menopause d) Old age

5. The process by which the sperms are produced is known as:
a) Ovulation b) Spermatogenesis
c) Oogenesis d) Gestation

6. The tube that carries the sperms out of the testes is the:
a) Vasa afferentia b) Vas deferens
c) Oviduct d) Epididymis

7. The process by which the sperms are released is called:
a) Spermatogenesis b) Oogenesis
c) Ovulation d) Ejaculation

8. The fertilization of human egg by the sperms takes place in the:
a) Ovary b) Oviduct
c) Vagina d) Uterus

9. The sterilization in males is called as:
a) Tubectomy b) Vasectomy
c) I.V.F d) G.I.F.T

10. The attachment of the embryo to the uterus is called:
a) Gestation b) Fertilization
c) Implantation d) Menstruation

11. The first time that the monthly bleeding occurs is called:
a) Maturity b) Menarche
c) Menopause d) Puberty

12. The part of the sperm that contains the lytic enzymes is:
a) Acrosome b) Nucleus
c) Midpiece d) Tail

13. Progesterone is secreted by:
a) Ovarian follicle b) Graafian follicle
c) Corpus luteum d) Corpus albicans

14. Sperms are produced at a temperature that is.....the body temperature:
a) Same as b) Lower than
c) Higher than d) Immaterial to

15. The life span of the sperm is:
a) 5 days b) 1-3 days
c) 1-3 weeks d) 7 days

16. The sperms are temporarily stored in:
a) Vas deferens b) Vasa efferentia
c) Epididymis d) Urethra

17. The lining or inner layer of the uterus is called the:
a) Cervix b) Vagina
c) Labia d) Endometrium

18. How many chromosomes does a human sperm cell contain?
a) 1 b) 2 c) 23 d) 46

19. During the excitement phase of intercourse, what makes the human penis enlarge and become rigid?
a) Blood b) Semen
c) Bone d) Tissues

20. The majority of semen is produced by the:
a) Seminal vesicles b) Seminiferous tubules
c) Prostate d) Bulb urethral gland

21. In humans, fertilization of an egg normally takes place when the sperm and egg unite in the:
a) Vagina b) Uterus
c) Fallopian tube d) Ovary

22. In the female reproductive system, sperms follow the following route:
a) Vagina-Cervical canal-fallopian tube-uterus
b) Vagina-cervical canal-uterus-fallopian tube
c) Vagina-fallopian tube-cervical canal-uterus
d) None of the above

23. Temporary methods of birth control which are the best suited to prevent transmission of diseases:
a) IUD b) Spermicides
c) Condoms d) RU- 486

ANSWERS:

1. a	**2. a**	**3. d**	**4. c**	**5. b**	**6.b**	**7. d**
8. b	**9. b**	**10. c**	**11. b**	**12. a**	**13.c**	**14. b**
15. b	**16. c**	**17. d**	**18. c**	**19. a**	**20. a**	**21. c**
22. b	**23. c**					

Contributed by Ms Anjum Fatima, C/o Iqbal Tahir, 28-1D-2A, Jyoti Nagar, Bagh Rajpur, Shaheed Nagar, Agra (u.P.) 282001

World Famous Statisticians

ARCHANA PANIGRAHI

1. He was an English statistician, evolutionary biologist and geneticist. His contributions to experimental design, analysis of variance and likelihood based methods have led some to call him "The Father of Statistics".

a) Thomas Bayes b) R. A. Fisher
c) W. Edwards Deming d) E. H.Wallodi Weibull

2. He was one of the pioneers of 20th century statistics. He worked on the design of experiments, including contributions to the theory of analysis of variance and originating an algorithm according to his name and the balanced incomplete block design.

a) Edwin Thompson Jaynes b) Blaise Pascal
c) Sir William Petty d) Frank Yates

3. He was a major contributor to the early development of statistics and founder of the world's first university statistics department at University College London in 1911.

a) Karl Pearson b) Captain John Grant
c) Pierre Simon Laplace d) A. N. Kolmogorov

4. He was an American statistician who contributed significantly to what is today known as the jack knife procedure. He introduced the box plot in his 1977 book, Exploratory Data Analysis.

a) Leland Wilkinson b) A. A. Cournot
c) John Tukey d) James Bernoulli

5. She was an influential American statistician and founder of the Department of Experimental Statistics at North Carolina State University. She became the first female elected into the International Statistical Institute in 1949. In 1950 she published a joint work with Cochran, Experimental Design, which quickly became a classic text.

a) Rosemary A. Bailey b) Grace Wahaba
c) Catherine Hewitt d) Gertrude Mary Cox

6. She was born in Denmark and wrote a thesis that was a precursor to modern optimal design theory, published in 1918 Biometrika. Her work with Pearson on minimum chi-square led to a controversial dialog between Pearson and Fisher.

a) Kirstine Smith b) Helen Berg
c) Jessica Utts d) Stella Cunliffe

7. She was the first elected female member of the Royal Statistical Society and one of the first people to collect statistics on health policy. Her work led to health policy reforms in nineteenth century Britain and saved lives of countless British soldiers. She is considered as "a true pioneer in the graphical representation of statistics".

a) Elizabeth Scott b) Ethel M. Elderton
c) Florence Nightingale d) Enid Charles

8. He was the pioneer of small sample analysis. His most important work was known as the "Student's t-test".

a) George E. P. Box b) William Sealy Gosset
:) Donald Rubin d) Roderick Little

9. He was one of the earliest pioneers for Weibull analysis and engineering statistics. He created a very large of number of statistical methods such as "step-stress" and some very clever investigative strategies.

a) Dorian Shainin b) Sir Arthur Newsholme
c) Walter A. Shewha d) L. M. Terman

10. He is one of the world's leading researchers in statistical data mining. He invented Gradient boosting, which is a machine learning technique for regression problems.

a) Harold Jeffreys b) Jerzy Neyman
c) Jerome H. Friedman d) Andrey Markov

11. He was born in Germany who spent much of his life studying the statistics of extreme values. "Extreme value Type 1" is known according to his name. It is employed for predicting maximum and minimum values, flood levels, wind gusts, the size of inclusions in metal.

a) G. Cantor b) A. Khintchine
c) Leo Breiman d) E. J. Gumbel

12. He is renowned for his pioneering work in computationally intensive statistical methods, particularly the bootstrap method. In 2005, he was awarded the National Medal of Science, the highest scientific honour by the United States, for his exceptional work in the field of statistics.

a) Francis Galton b) Bradley Efron
c) Pierre de Fermat d) H. C. Romig

13. He is a British statistician who has made pioneering and important contributions to numerous areas of statistics and applied probability. He is known for his proportional hazards model, which is widely used in the analysis of survival data.

a) Carl Gauss b) Teuvo Kohonen
c) Sir David R. Cox d) A. L. Bowley

14. He was a leader in the development of mathematical statistics. He developed the theorem on the distribution of the likelihood ratio, a fundamental result used in a wide variety of situations.

a) Samuel S. Wilks b) Simeon Denis Poisson
c) David Blackwell d) Emanuel Parzen

ANSWERS

1) b 2) d 3) a 4) c 5) d 6) a
7) c 8) b 9) a 10) c 11) d 12) b
13) c 14) a

Contributed by Ms Archana Panigrahi, C/o Kalpana Mishra, Bhugudakata, PO Bhanjpur, Baripada, Distt Mayurbhanj, Odisha–757002; Email: archanapanigrahi10@gmail.com

"Is the Creation of Designer Babies Wrong?"

Designer baby in simple terms refers to the privilege given to the parents to design their babies' features (hair colour, eye colour, etc). With rapid advancements in technology, proliferation of this technique doesn't seem far away. But use of this technology has many negative implications. It may create a class of genetic elite, as it will be the rich only who would have the resources to opt for this, thus increasing the social inequality. For doctors, it will be just a cash business, which is against their medical ethics. Also, this could raise the expectations that parents have from their 'designed children', and may lead to frustrations when these are not met. Further in countries like India, it can be used to avoid the birth of female children.

Palak Goel
Panchkula

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People may say we already alter genes in animals and plants, and we select people naturally, such as tall, skinny people. Animals are genetically engineered, such as cows to produce the best beef, plants for the biggest tomatoes, and so on. But those are for consumption purposes. These are not our children we are talking about. And while most of us do try and select mates who are, for example, tall and skinny, genetics is influenced by the genes of the parents, but not completely. To an extent it is random.

When we actually pick and choose our children's genes, we are reaching the point when we are playing God. And although I agree there are some instances where you may want to get rid of a gene, for, say, Tay-Sachs, a fatal disease which probably also makes the child suffer throughout their short life, that's different. Getting rid of a disease is a benefit to the child, as they will be spared from suffering. This, on the other hand, is for cosmetic reasons alone.

These "designer babies" are created simply so a parent can boast they have a "perfect child": muscular, smart, beautiful. Other than giving a child cosmetically "better" genes, it does nothing, and, in fact, it may even embarrass the child, knowing their traits are not genuine, and may make them feel not unique.

Also, when we say, "Well, it could lead to better behavior." Really? This may sound like an odd allegory, but raising a child is honestly not that different from raising a pet. While you don't train your child to "sit" and "stay" and "roll over", you do teach them to be good kids, and have manners, and so on. What happens if you're a good trainer? You get a good dog. What happens if you raise your kid well? You get a good kid. You don't just "inherit bad manners", it's the way you are raised. Not to mention that this would lower the gene pool, which is dangerous for a species.

Oh, and by the way... Hitler, anyone? This is unethical in every sense of the word.

Anamika Sharma
Class 11a, Kendriya Vidyalaya
Lakhanpur

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The creation of designer babies raises questions on moral issues, and is definitely WRONG. Evolution has its own course and it basically implies that as environments change, the individuals in a species best suited to the new environment are selected for. Creating a generation of modified human beings can mess with the evolutionarily processes in unpredictable ways and have disastrous effects on the human gene pool. Creating babies through genetic engineering may accidentally introduce new diseases, create chaos and imbalance in nature. Moreover why would anyone want to mess with a helpless, unborn child; they are babies and not 'dresses' that should be designed!

Pramita Roy
Barasat Govt. College, West Bengal

****

A designer baby is a baby genetically engineered in vitro for specially selected traits, which can vary from lowered disease-risk to gender selection. We all know that designer babies are likely to become the 'thing' of the future.

However, despite the useful applications, this debate has sparked vast amounts of controversy. People will be able to change their child's eye colour, hair colour or possibly even how intelligent they are. I don't agree with it, nature should do as it intended and people should be happy for the children they are given. I can understand parents wanting the option to stop their children being unhealthy or disabled if there is a possibility, but the way the child looks should be irrelevant. Animal studies have shown that this type of genetic engineering is unpredictable. There is a huge risk that we may produce physical changes, or even change the child's personality. Mice, whose genes had been changed to make them more muscular, unexpectedly became very timid compared to other non-genetically engineered mice.

Bikash Chandra Jena
Bhubaneswar, Odisha

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The idea of going for designer babies is ill-conceived. It is not proper to defy natural processes. Science is for the benefit of society. It has to play a subservient role to nature and not don the mantle of the creator. Moreover, the full implications and consequences of the procedures are still not completely known. To take the giant leap forward and venture into 'terra incognito' is fraught with dangerous consequences. The society is simply not prepared to accept the disadvantages and the inherent risks.

Shashi, Indore

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No, it will not be wrong if people do not misuse it. It could be a wonderful progress of science and also of human civilization that there will be no unhealthy babies in our world after the creation of designing babies.
Adriza Saha,
Kolkata

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Creation of designer baby is wrong. Rich people can create designer baby to have child of their choice because the creation is very expensive. They can design their baby as clever and intelligent. The status of the poor people will be further reduced in society.
Dashmee Prasad Jaiswal
Varanasi (UP)

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Human beings are created by nature and every human gets natural goods or defects. In this era of technology, the creation of designer babies can be very helpful in removing natural and genetic defects of humans like diseases and personality defects. But it should be implemented in such cases only. This technique should be used in a controlled manner.
Tushar Ketan,
Class IX,
Mithila Public School, Bihar

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Though the process of creation of designer babies can allow some couples to have babies without any genetic disease yet this would have some negative impact.

The genetic techniques for the creation of designer babies are very expensive and if this technique is practised then it would be confined to the upper rich class of the society. But then do only the rich people have the right to get babies with desired characteristics, without

any genetic disease? Moreover this technique will pave the way to determine the sex of the embryo, which is totally illegal under any circumstances. Therefore the creation of designer babies will definitely create natural, social, legal problems as well as a complete imbalance altogether.
Soumadip Sen
University Institute of Technology, West Bengal

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The benefits of science must be embraced unanimously. The creation of designer babies is a marvel of biotechnology and bio-engineering just like IVF. So, I see no wrong in its creation. The sophisticated drugs and vaccines that are often taken by us are also designer in that sense. If we can accept that, why not babies? Moreover, creation of designer babies will definitely not be a substitute for natural propagation.

Mayukh Bagchi
Class 12, Douglas Memorial H.S. School, Barrackpore

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In today's world when most babies are being born with some sort of defects or falling prey to some heritable or genetic diseases later on in their life, it's not wrong to create designer babies. After all everybody wants to be healthy in today's modern world, so if it's possible to eliminate or reduce the chances of defects or catching diseases then what can be more good than this.

Also, because of the changing lifestyle, conceiving baby has become a problem, so it will be a boon for those childless parents who are longing to have a baby. Of course, some might have ethical reasons to avoid it, but a healthy and happy life is what is more important nowadays.

Neema Kumari
M.Sc., Banasthali Vidyapith, Rajasthan

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Very soon the day will come when parents will start deciding the type of quality to be possessed by their child at the time of birth. So, if parents want that their child must become an athlete, a good sports person or as intelligent as a Newton or Edison with the help of this technology they may and they will. But, if with the help of this tech, everyone will be excellent in everything then who would be worst in at least one thing?

Nupur Mala
Class 8,
Carmel School, Hazaribag

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Designer babies – the allusion here is that we move away from the arms of nature. When every child born is prodigious, beautiful or an amalgamation of all desired traits, who will be the fittest to survive? It creates enigmatic chaos on ethical, cultural, social and legal grounds in the long run. The upcoming generations will find hard to associate themselves with human beings. Babies may become commodities of commercial importance.

S. Nithila Priyanthi

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Designing a baby is good as far it is concerned with the removal of any kind of incurable diseases. But the actual working of the technology may be highly complicated. It is probable that the parents get a girl with all good qualities, but with a terribly mean personality, because "Personality Genes" are difficult to interpret. It is also a fact that if everybody wants their progeny to be healthy and bright then there would be no variation left among the humans.

Joyeeta Chakraborty
Class 10,
KV Barrackpore Airforce

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No, not at all! In fact the journalist's term "Designer babies" should be replaced by scientific term "Perfect Babies". It is a process to create a healthy and perfect baby, free from abnormalities. Many genetic disorders could be removed by using only genetic engineering that ultimately leads to the safety of a life. Creating designer babies is not ethically wrong as this technology can save those millions of the babies who are born with disorders in their natural genetic make-up. This is the only solution to 'female foeticide' and abortion as this technology may provide us with a desired sex, colour of eyes and IQ.
Bilal Naik
Iqbal Memorial Institute, Srinagar

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Nowadays people are busy designing their body by painting with various designs of tatoos, mehendi or different colours. Plastic surgery of different limbs like nose and lips are common trends. Similarly, the use of colourful lenses and golden teeth merely for the style and design. So if the adult can design themselves as they like then why not for the babies? Because they are not adult but according constitution parents have the right to take any decision for their baby until they become adult. So there is nothing wrong in creation of designer baby according to demand.

Jeemey Kibria

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The future of genetic engineering is full of many possibilities, good things and improvement for our society. Currently designer baby technology is only used to make sure the parents of a future child will not have a child with an incurable disease. However, it is only a matter of time before a doctor or company will put a price on other aspects of the genome of the baby. The technology can even be dangerous right now as it is to the embryos.

Ghanashyam Gouda

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The evolution of humans has spanned about 2 million years and has resulted in the types of people we see today – people who have imperfections and people who are very different from one another. A variety of species is necessary for them to be competitive and successful.

By creating a generation of genetically similar people the human species loses its ability to adapt to changing environments. Furthermore, on moral grounds, whether it is believed that humans evolved or were created by God, it is wrong to try to perfect something that has been perfected over a large span of time.

Ansh Kumar Bharati
Odisha

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If designer babies were to become common place, individuality as we know it would most likely cease to exist. Not everyone would look exactly the same; some parents may want their baby to have brown eyes, as opposed to green. Other parents may want their child to be more tan skinned rather than fair skinned. But as a whole, many people would be pretty, healthy and intelligent. Which parent wouldn't want these basic traits in their child?

Designing a baby costs money, and will most likely continue to cost lots of money. Genetic engineering for non-medical reasons is not necessary for living life and it is doubtful that those who could not afford it would get reimbursed by insurance companies. This cost will mean that not everyone will be able to pay to design their baby and suddenly people will encounter prejudice, not for their race, but for their inferior genetic make up. It creates a new class system made up of genetically designed people and naturally made people. The people who were not genetically engineered would experience a loss of opportunity based on a chance that their defective genes will be expressed.

Another potential long term problem of designing babies lies in societies in which one gender or other important characteristic is favoured over the other. In countries such as China and India where boys are favoured over girls, this technology could be used so that every set of parents that wants a baby boy will get one. However, that is not evolutionarily favourable. If a generation of only boys are to be made, the human race would die out. That is, nevertheless, difficult to explain to an entire country, where family pride is based on the number of sons one has. The technology would continue to be abused.

Jitu Kumar Bharati
Odisha

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A quick rational insight into the concept of designer baby shows that it is wrong for the very fact that here baby is not born but manufactured according to quotation. On ethical grounds too many thinktanks opposed it as they foresee a genetic imbalance in near future. This could make babies prone to new diseases.

Pramod Rao Errabelli
Old Rajendra Nagar,
New Delhi

Now write in your thoughts on this topic:

"Species loss is a natural result of evolution."

Be short, crisp and logical. Send in your photo, if you like.

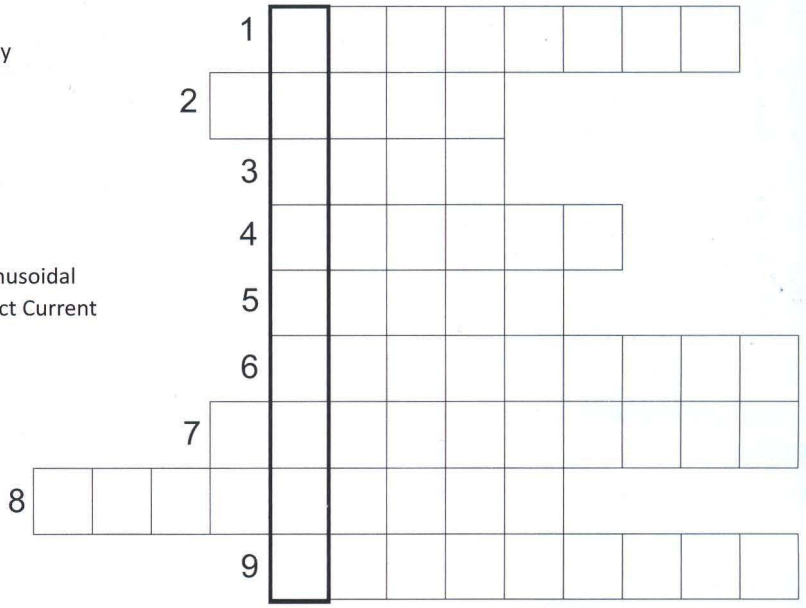
Prize Puzzle

BASIC SCIENCES QUIZ

Fill in the following grid, using the clues given. The dark vertical column gives the name of the device that produces Electricity.

CLUES:

1. Branch of science dealing with heredity
2. A measuring unit
3. An inert gas
4. Capacity to do work
5. Rotating part of a machine
6. Strengthens the signal
7. Enhances the power
8. Concerned with waveforms, mostly sinusoidal
9. Converts Alternating Current into Direct Current



Contributed by Mrs Seetha Devi Addanki, Teacher (Biosciences), St Joseph's Public School, A.G. Palace, Malakpet, Hyderabad-500036 (AP)

There are three prizes of Rs 500/- each for three correct entries. In case of a large number of correct entries, the prize winners will be selected through a draw of lots. The decision of the Editor, *Science Reporter* will be final.

Send your entries to:
Puzzle Corner
Editor, *Science Reporter*
National Institute of Science Communication & Information Resources (NISCAIR)
Council of Scientific and Industrial Research (CSIR)
Dr KS Krishnan Marg, Pusa Campus
New Delhi-110012

Last date for the entries to reach us: 05-07-2014

Name : .....

Address : .....

.....

..... Pin code: .....

Age : ..... Email: ..... Sex: .....

Occupation : ☐ Student ☐ Housewife ☐ Teacher ☐ Professional ☐ Retired ☐ Other

Educational level : ☐ Primary ☐ Secondary ☐ Graduate ☐ Postgraduate

- *Please fill up the questionnaire at the back*
- *You can send your answers on a photocopy of this page as well.*

LANGUAGE NEWSPAPERS

A newspaper vendor sells dailies in 4 different languages. Sensing public demand, he adds 3 Telugu dailies, and the ratios of dailies sold become:

English: 1/3
Hindi: 1/4
Bengali: 1/6
Urdu: 1/8

Find out the number of dailies in each language, and the total number of dailies sold?

V.N. Ramaswamy, Abhishrey Hostel, Sunny Palace, 3-6-728, Himayatnagar, Hyderabad-500029

SPOT TEN DIFFERENCES

Find the ten differences in the pictures of 'Knight and the Princess' shown below.

Contibuted by Neeru Sharma, CSIR-NISCAIR

Solutions to the puzzles published in the March 2014 issue

Prize Puzzle:

LANGUAGE PILLAR

C
C#
C++
JAVA
COBOL
PASCAL
MACHINE
ASSEMBLY

MURDERER?

Jamie died of carbon dioxide poisoning. The pole was 5' long, but only the size of a quarter.

The first time he breathed in, he breathed oxygen. When he exhaled, the air could not travel 5' before he breathed in again. He was just breathing what he exhaled. Before long, all he was breathing was carbon dioxide. He died of CO_2 poisoning.

Doctor Dodge was the one who told him to use the pole, therefore the cause of his death. Dodge is a DOCTOR, and therefore knows about the CO_2. Dodge did murder Jamie. His motive: the money in the will.

DAY PUZZLE

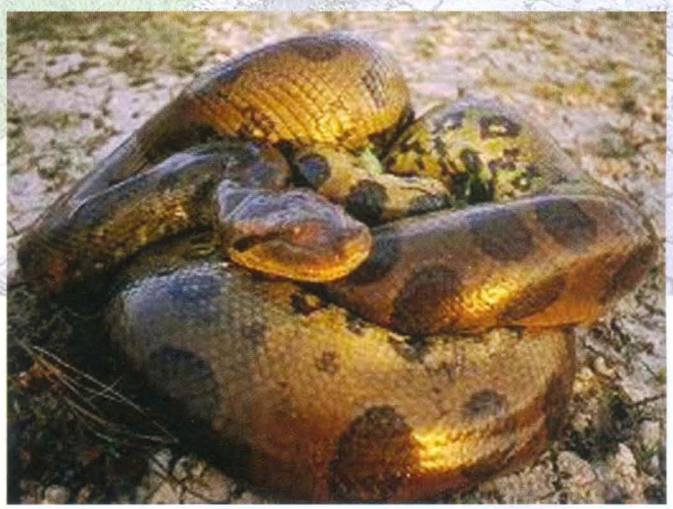
1. Jan 30 – World Leprosy Eradication Day
2. Feb 04 – World Cancer Day
3. Mar 24 – World Tuberculosis Day
4. Apr 11 – World Parkinson's Day
5. Apr 17 – World Haemophilia Day
6. Apr 25 – World Malaria Day
7. May 17 – World Hypertension Day
8. Jun 05 – World Anti-Filaria Day
9. Jul 06 – World Zoonosis Day
10. Jul 28 – World Hepatitis Day
11. Sep 21 – World Alzheimer's Day
12. Sep 28 – World Rabies Day
13. Sep 29– World Heart Day
14. Oct 10 – World Mental Health Day
15. Oct 12 – World Arthritis Day
16. Oct 20 – World Osteoporosis Day
17. Oct 24 – World Polio Day
18. Nov 14 – World Diabetes Day
19. 2nd or 3rd Wednesday of Nov – World COPD Day
20. Dec 01 – World AIDS Day

The names of the prizewinners based on the draw of lots from among the correct entries are as follows:

1. **Aranya Mandal** (14 yrs), Vill. & Post Harda, PS Binpur, Dist. Paschim Medinipur, West Bengal-721507
2. **D. Yashaswi** (20 yrs), Room No. E-107, Mother Teresa Hall, IIT Campus, IIT Kharagpur, West Bengal-781302
3. **Jagjit Raman** (21 yrs), Room No. B/214, Neelkanth Boys Hostels, NIT Hamirpur, Dist. Hamirpur, Himachal Pradesh-177005

Congratulations all the winners!

Giant Anaconda



THE movie version of this largest of all snakes was awesome and terrifying! Over the years, however, the anaconda has had to live with much exaggeration and scary folklore. Travelers' diaries and notes often refer to 140-feet monsters.

Without doubt though the Anaconda is the heaviest and most powerful snake in the world, it is also one of the most horrifying reptiles to behold. It weighs about 250 kg. Females are usually bigger than males. Also known as the Water Boa, this giant meat-eater lives in swampy areas of tropical South America, east of the Andes, mainly in the Amazon and Orinoco basins and in Guiana. The Anaconda is a powerful swimmer and can navigate as well up current as down current even in floodwater.

Like all snakes, anacondas are cold-blooded. They continue to grow all their lives, getting bigger and bigger each year. The longest specimen on record was a little over 37 feet. Their average lifespan is 10 years, may exceed 30 years.

The Anaconda is most infamous for its dreadful lurking nature. It has the terrifying habit of remaining quite still for hours on end well hidden from sight, and then quite suddenly striking out at any unfortunate beast that wanders a little bit too close in search of water. It lies hidden in shallow, cloudy and silted up water and so is very hard to spot. It also strikes from the cover of thick swamp vegetation such as Water Hyacinth.

No beast is able to defend itself against constriction because Anaconda is able to totally subdue and envelop its prey very quickly. They've even been known to attack jaguars and sometimes humans. Their jaws can stretch really wide because of a special ligament that connects them. They usually swallow the victim head first so that the legs do not get stuck on the way down.

Death is through suffocation; the suffocated victim is swallowed whole and in one piece. No beast is able to defend itself against constriction because this snake is able to totally subdue and envelop its prey very quickly. Anacondas can devour whole pigs and deer at one sitting. They've even been known to attack jaguars and sometimes humans. Their jaws can stretch really wide because of a special ligament that connects them. They usually swallow the victim headfirst so that the legs do not get stuck on the way down. Like a crocodile it only needs to feed once every few months, it can go up to four months without feeding.

Out of water the Anaconda is very sluggish and rarely dangerous. Its body is far too bulky to launch an effective strike on land, in the water though its body weight is easily supported. It is most effective at night.

Anacondas are viviparous and thus give birth to live young. Sometimes as many as a hundred may be born but most often it gives birth to 20 to 30 babies around two feet in length. Many fall prey to other predators in the food chain.

National Conference "Public Undersanding and Public Engagement with Science, Technology and Innovation"

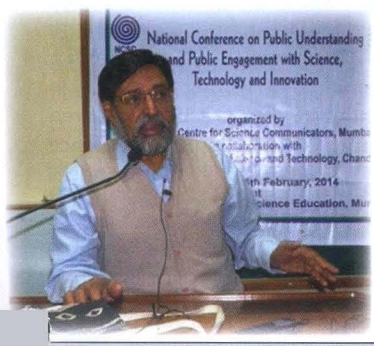
SUHAS B. NAIK-SATAM, PARUL R. SHETH, & A.P. JAYARAMAN

A wide-ranging variety of topics and issues were thrashed out at the recently held National Conference on "Public Understanding and Public Engagement with Science, Technology and Innovation" held on 15-16 February 2014 at the Homi Bhabha Centre for Science Education, Mumbai. The conference was jointly organised by the Punjab State Council for Science & Technology (PSCST), Chandigarh and the National Centre for Science Communicators (NCSC), Mumbai.

Laying down the agenda and the road forward for the conference, Dr. Parul Sheth, Science Communicator and Treasurer

with the National Centre of Science Communicators, Mumbai, in her opening remarks at the inaugural function mentioned that the aim of the conference was to focus on the various modes of science communication in order to engage the general public with science, technology and innovation.

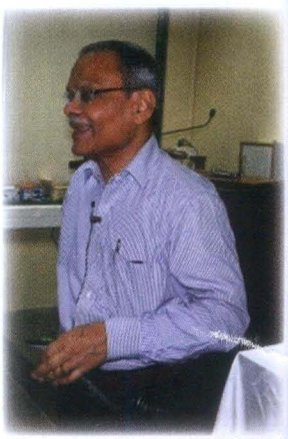
Carrying forward the thought, Dr Suresh Mahajan, former Head, Molecular Biology and Agricultural Division, BARC, and Gharda Professor of Biotechnology, Institute of Science, Mumbai, in his incisive and insightful keynote address gave an exposition of the impact of innovation in developing countries undergoing globalization. He warned of the pressures to commercialize research results of foreign countries in developing countries with scant regard for indigenous regulatory agencies. He cited examples of such practices in bt-brinjal, cotton and bovine growth hormone. He exhorted science communicators to focus on innovation and keep vigil.



Dr. Neelam Gulati Sharma, Director in the Punjab State Council for Science and Technology, Chandigarh presented a bird's eye view of the multifarious science communication initiatives in Punjab to bridge the knowledge gap. She said science communication is the need of the hour and the only way to enlighten the masses is by inculcating scientific temper through the print, electronic and digital media as well as traditional folk forms.

In the session on Communicating science through print and electronic media, Mrityunjay Bose, Assistant Editor, Sakal Media Group, Mumbai lamented the absence of dedicated science correspondents in the Media and the editorial disdain for science news. He remarked that the government was doing better than the private sector by bringing out magazines like Science Reporter and with Doordarshan and AIR beaming high-quality scientific programmes.

Mr. Biman Basu, former editor, Science Reporter, traced the growth trajectory of science magazines and outlined the history of Science Reporter and dynamic sustainability. He mentioned that a popular science magazine is one of the most effective media for dissemination of the newest developments in S&T. It is easily accessible and provides a broad-based platform for popular treatment of wide-ranging science disciplines not available through scholarly journals.



Mr. K.V.S.Seshasai, CEO, Zee Learn, Mumbai while talking about science communication through television said one of the popular images associated with science in India is that of a scientist in a lab coat. A technocratic image of science limits the communication about science to the field of discoveries and technological innovations. Despite many attempts at making science a 'way of life', it is often treated as a possession. A dedicated edutainment TV channel for children has a great scope of making science look less like a possession and more like a lifestyle experience. Communication through television is a powerful tool for shaping attitudes and preferences at an early age. He stressed the need to make science fun and to focus on every day science with caution to not throw away classic textbooks.

Talking about radio programmes, Mr A.S. Dhindsa, lecturer, District Institute of Education and Training (DIET) at Sangrur, Punjab, described the methodology and techniques for the production of science radio serials. Good radio programmes are a mixture of inspiration, talent and craftsmanship. Radio drama/play used to be in the mainstream but recently have lost out to TV, Mobile and Internet. He outlined protocols for radio storytelling. He also gave tips on how to get the listener inside the realm of the programme by creating curiosity about the subject.

Dr. Anil Sharma, Assistant Director, Centre for Communication and International Linkages, PAU, Ludhiana spoke in the second session on Communicating science, technology and innovation through multimedia. He talked about science communication through traditional media like plays and vernacular songs.

Prof. Rohini Chowgule, Professor and Head of the Department of Medicine at Bombay Hospital, Mumbai, talked about telemedicine. She described the rapid integration of technology into medical practice. She mentioned that 700 million Indians are outside the medical support umbrella and pointed out inadequate allotment to health care sector at 2.5% of GDP.

Dr. Balwinder Singh Sooch, Assistant Professor, Department of Biotechnology, Punjab University, Patiala talked about Protection of Innovations under Indian IP regime. He mentioned that Intellectual Property is the property of one's mind or intellect that leads to an innovation. Innovation is the driver for economic development and wealth creation in the 'knowledge based economy'. Further, the progress and prosperity of a nation depends on the level of scientific, industrial and technological development.

Dr. Alok Thakor, Director, Font & Pixel Media Pvt. Ltd focused on the inherent problems of language in communicating 'science'. He emphasized the need for jargon-free natural language in science communication and advised scientists to check on reality rather than on textbook sermons. He shared the difficulties of a creative artist collaborating with a scientist to make science comprehensible.

Ms Margie Sastry, former Associate Editor, Tinkle and Amar Chitra Katha, in the session on Enhancing science education and media networking narrated the colourful history of science communication and how her creation of science characters made a massive impact in the minds of children by making science attractive and acceptable

Dr. T.V.Venkateswaran from Vigyan Prasar, New Delhi briefed about EduSat Education Satellite Technology. He quoted the Tele-education Mission Document, a report published in 2001 by the Gramsat Programme Unit of ISRO's Development and Education Communication Unit (DECU), which had identified the need for a dedicated satellite dedicated to education. He said EduSat was expected to fulfil several of India's needs in education. He presented the objectives of EduSat for capacity building of quality teachers.

Ms. Saraswati Iyer, former Director, Jawahar Bal Bhavan, Mumbai demonstrated low cost high-impact educational aids that would help teachers deliver easy and effective science education to kindle the curiosity of children by engaging them in various novel `Scientific Activities` involving Innovative object based learning techniques.

Dr. Narottam Sahoo, Adviser, Gujarat Council of Science & Technology (GUJCOST), Gujarat, talked about the approach and methodology of the Gujarat Science City which is focused on informal community based learning. All the programs are intended to enliven the imagination, foster creativity and develop a spirit of inquiry, especially in young minds. He mentioned about school children visiting Gujarat Council of Science City who discover the wonders of science and technology and get access to the most exciting and contemporary form of entertainment regardless of the social stratum, education or age

group and create a culture of learning. He shared the experience of planning, designing and executing a state-of-the-art Science City and making it economically sustainable.

Dr. Manasi Rajadhyaksha, former secretary, Marathi Vidnyan Parishad, and now Director, Concepts India Ltd., spoke in the last session on Evaluation, impact and strategic monitoring of science communication. She presented the structure and dynamics of a social survey conducted by the Marathi Vidnyan Parishad (MVP) to assess the base line scientific literacy and post program status to produce evidence-based metric for monitoring science communication projects.

Dr. T.V. Venkateswaran from Vigyan Prasar, New Delhi spoke about evaluating science communication programmes. He said that evaluation of a science communication project is not simple or straight forward as it may appear at first sight. As a social science activity it is embedded in many levels of contestations and hence requires conscious choices to be made. He also said that a large number of science communication activities aim broadly to generate public interest in science.

Prof. Chhaya Datar, former Professor of Tata Institute of Social Sciences (TISS), Mumbai expounded the concept of Jalswarajya as a tool for women empowerment. She presented a study case of demand and supply side of a water management project with conflicts from privileged and under privileged communities.

Dr. Arnab Bhattacharya from the Tata Institute of Fundamental Research, Mumbai talked about Chai-and-Why?, a unique outreach initiative of TIFR to take science out to the public based on an informal, accessible science-café-like platform. Though science and technology underpin societal progress, there is a general lack of awareness in the Indian public. The programmes are conducted by professors and postgraduate students from TIFR.

He said that Chai-and-Why? was started in 2009 to bring TIFR's science into the public domain. It now runs twice a month with a remarkable range of topics such as science of colour during Holi, fireworks during Diwali, science behind topical news such as wireless networks etc. The programme excites children into the realm of science.

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Dr Parul R. Sheth and Dr A.P. Jayaraman are also with the National Centre for Science Communicators, Mumbai

Speaking for Science

Ramchandra wrote prolifically on what he considered to be irrational and unscientific beliefs that had crept into Indian society over a period of time. He urged the readers to look at events and ideas rationally and not through traditional eyes.

Master Ramachandra

ONE of the major presumptions about the progress of knowledge in the erstwhile British colonies had been that it was mostly an import from the West. This ideological bias is still held by some as valid, yet majority of the serious scholarship has moved away from it. The Arabs are no longer considered as mere transmitters of ancient Greek knowledge. There is enough evidence to prove that the Greek scientific works were translated and researched upon before being passed on to Europe.

Indian contributions to scientific knowledge over the centuries have been no less. To speak of one such instance, if one looks at the intellectual climate and people's perception of science in the 19th century, one comes across the name of Master Ramchandra, a mid-19th century intellectual and mathematician of Delhi – a man who wrote forcefully against unscientific beliefs and superstitions, besides several articles and books on popular science subjects.

He had been a pioneer Urdu journalist, considered to be one who belonged to the avant garde of realist writing in Urdu. His Haqeeqat nigari (realist writing) was actually representative of all the cultural figures of Delhi who included men like Alauddin Khan Alai, Munshi Pyare Lal Ashob, Syed Ahmad Khan, Mirza Ghalib, Altaf Husain 'Hali', and many others.

Ramchandra was born in 1821 at Panipat in a Kayastha family. His father Rai Sunder Lal Mathur was an employee of the revenue department, posted at Panipat when Ramchandra was born. Otherwise, the family had lived in Delhi and was very much part of the culture of Shahjahanabad. He was brought up and educated by his mother as his father died early when Ramchandra was just nine years old.

According to tradition, he had his early education at home and was admitted to an English school in 1833. Ramchandra excelled at school and earned scholarship to take care of his minor expenses. He was particularly bright in mathematics which he pursued on his own as there were no arrangements to teach the subject at school.

He was married early at the age of eleven, but unfortunately, his wife was deaf and dumb. Despite the economic hardship

Ramchandra's project succumbed to the politics of power as well as to the politics of knowledge. He belonged to the Delhi Renaissance, which ran out of steam under a hostile political dispensation.

and the difficulty of caring for an invalid wife, Ramchandra single mindedly pursued his academic activities.

He became a science teacher and mathematician at Delhi College (present day Zakir Husain Delhi College at Ajmeri Gate). In this capacity he wrote a book on mathematics in Urdu called Sari-ul-Fahm, where he tried to bridge the algebraic tradition of the Indian and Arab worlds and the more modern concept of mathematics that had emerged in the wake of the new calculus. He went on to write two books in English called A Treatise on Maxima and Minima (published in England in 1859, at the insistence of Augustus De Morgan, a British algebraist and logician) and a second work called A Specimen of New Method for Differential Calculus called the Method of Constant Ratios (published from Calcutta in 1863). These books were written in English which shows that they were not intended merely at Indian readership but were written to raise a pedagogical issue that was essential to the teaching of calculus even in the West.

Ramchandra was convinced, as seen in these books, that the Indian and Arabic traditions of mathematics were essentially algebraic and so set about developing a calculus that did not require a deep foundation in geometry. So the first book begins with a knowledge of the theory of equations as found in Bhaskaracharya's Bija-Ganita, and then proceeds to obtain the maxima and minima for any polynomial function.

The second book of Ramchandra dealt with the foundational problem in calculus. Here he tried to develop a more generalised method for calculus along the lines discussed in the earlier book. He felt that the fluxional method was problematic, since it was not free of the notion of limits. The infinitesimal method was suited for obtaining differentials, but was still grounded in the notion of limits. According to Ramchandra, the method of limits was the best available method though it required infinitely small and great terms.

Ramchandra was a great enthusiast of the vernacular medium of instruction. He felt that instruction in the mother tongue is more instinctive and natural, which was in marked contrast with the Macaulayan objective of producing clerks or to put aptly in Macaulay's oft quoted works: 'Indians in blood and colour but European in taste and manners.' Ramchandra's rationale for using the local language as the medium of instruction was that it would facilitate the task of communicating precious knowledge and will also enable the Indians to make the achievements of science their own, and thereby contribute to the development of knowledge.

Ramchandra took up translation of European scientific works into Urdu, begun by Mr Boutros, the principal of Delhi College. These activities were later formalised under the aegis of the Vernacular Translation Society. Ramchandra's papers Fawaid-ul-Nazrin and Qiran-us-Sadain were published initially by this Society. These papers sought to bring out what was good in the cultures of the East and the West and also present a unified viewpoint.

Fawaid-ul-Nazrin carried articles of new inventions, discoveries and research in modern science and technology. Most f this work was in the French encyclopaedist tradition. All these popular articles were not merely projecting the emerging world-view of science but they were inflective of his own reading of it. They were attempts to transform Urdu – a language known for poetic expression – into a vehicle for expressing social dissidence and commentary.

Ramchandra wrote prolifically on what he considered to be irrational and unscientific beliefs that had crept into Indian society over a period of time. He urged the readers to look at events and ideas rationally and not through traditional eyes. He writes about his preliminary attempts in this direction.

"We were ambitious enough to imitate the plan of The Spectator. We first commenced a monthly, and then a bi-monthly periodical, called the Fawaid-ul-Nazrin in which notices of English science were given, and in which not only were the dogmas of the Muhammadan and Hindu philosophy exposed but many Hindu superstitions and idolatries were openly attacked. As a result many of our countrymen, the Hindus, condemned us as infidels and irreligious."

Ramchandra's critique of Indian society did not refract through the prism of European enlightened thinking, but was a part of those critiques which were emerging since the 18th century in the country. He wrote extensively in his Fawaid against the widely prevalent beliefs about chhalawa, bhoot and several such superstitions. He also tried to impress upon the people the fraudulent basis of magic, and that to be a successful magician one needs to know a little physics. He wrote a book as well, titled Bhoot Nibang, warning his countrymen against all sorts of superstition.

Ramchandra was in tune with the Baconian programme emphasising empiricism. He was highly critical of classical Indian scholasticism which confronted him in the debates with repositories of traditional learning, the pandits and the moulvis. Making a scathing attack on the traditional organisation of the Madarasas and the method of education, he wrote in his paper: "Gulistan is taught in schools. The teacher merely explains the meanings of various words to the student and then the student sits at a distance from his teacher, repeating the lesson like a parrot. He is not concerned about what Shaikh Saadi has written in Gulistan. He is concerned only with its literal meaning."

Unfortunately, neither Ramachandra's emphasis on the vernacular medium of instruction nor his pedagogic interventions in mathematics could find any takers in the post-Macaulayan phase. Ramchandra's project succumbed to the politics of power as well as to the politics of knowledge. He belonged to the Delhi Renaissance, which ran out of steam under a hostile political dispensation, and Calcutta was to emerge as the epicentre of modern science.

Ramchandra became a Christian in 1852 and his life was in serious danger during the 1857 revolt. Most of the Christians were suspected. So Ramchandra also had to run for safety with the help of his loyal servant. He remained in Roorkee as a Native Headmaster of Thomson Civil Engineering College but came back soon to Delhi as a Headmaster of Delhi District School in 1858.

He retired early on health grounds in 1866, joined the services of the Maharaja of Patiala and took over as director of education in 1870. Most of his later life was spent in Christian missionary activities.

Ramchandra's health deteriorated fast and he died on 11 August 1880, at the age of merely 59.

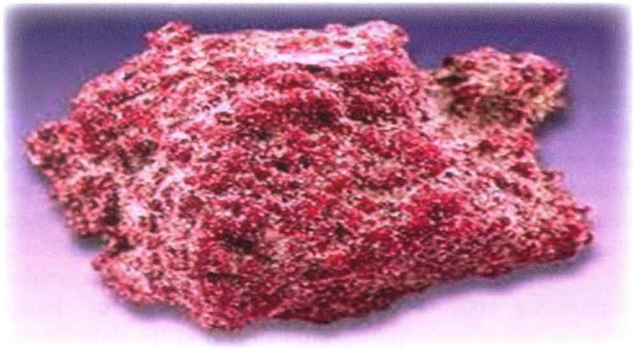
(By S. Irfan Habib, Reproduced from *Achievements in Anonymity*, CSIR-NISCAIR publication)

Minerals and Rocks in Environment

PREETI KUMARI

1. The name of the crystal is Dragon Blood, it is the main ore of mercury. This mineral releases pure mercury when disturbed or heated causing tremors, loss of sensation and even death. Name the mineral.

a) Stibnite b) Galena
c) Cinnabar d) Asbestos



2. Which ore of copper shows a play of color like peacock feather and is also known as peacock ore. It is considered an excellent healing stone. Name the mineral.

a) Pyrite b) Chalcopyrite
c) Bornite d) Pyrrhotite

3. Steatite, which is also known as hydrated magnesium silicate, is the main component of soapstone. It is the purest form of which mineral?

a) Soapstone
b) French chalk
c) Potstone
d) Talc

4. Among the following, which variety of clay is also known as natural bleaching clay? It is used for domestic purpose as well as by military and civil service personnel to decontaminate the clothes and equipment of servicemen which have been tarnished with chemical agents?

a) China clay
b) Fire clay
c) Fullers earth
d) Bentonite

5. These minerals due to their high specific gravity occur in the sands on foot hills or valley floor. They are also known as placer deposits. Which among the following is one?

a) Coal
b) Bauxite
c) Quartz
d) Gold

6. Brownish-black color coal, which has a carbon content of around 25-35%, a high inherent moisture content sometimes as high as 66%, and an ash content ranging from 6% to 19% compared with 6% to 12% for bituminous coal, is known as?

a) Lignite
b) Peat
c) Bituminous
d) Anthracite

7. Which of these gem minerals is composed of only one element and tetrahedral bond in covalent network lattice?

a) Emerald
b) Diamond
c) Rutile
d) Garnet

8. This volcanic light weight and light colored rock is often used to remove dead or excess skin because its surface is highly vesicular and rough. What is it?

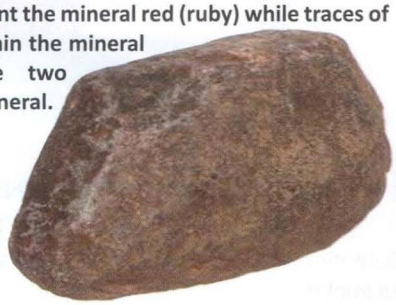
a) Obsidian
b) Agglomerate
c) Basalt
d) Pumice

9. The beaches of Kerala are known for their serene beauty but at the same time the sands there are harmful as they radiate harmful radioactive rays. Name that radioactive mineral?

a) Uranium b) Rutile
c) Thorium d) Strontium

10. The basic chemical formula of Rubies and sapphires is the same, but traces of iron tint the mineral red (ruby) while traces of chromium or titanium stain the mineral blue (sapphire). These two associate to the same mineral. Which mineral is that?

a) Corundum
b) Quartz
c) Calcite
d) Mica



11. Over a long period of time while under extreme heat and pressure, graphite turns into which precious mineral?

a) Sapphire b) Diamond
c) Garnet d) Emerald

12. Farmers usually use this mineral in their field as it reduces acidity and enriches the soil in Magnesium and Calcium. It also enhances the filtration of water in soils which are acidic. Name the mineral.

a) Sandstone
b) Limestone
c) Shale
d) Clay

13. This mineral is treasured for its rich blue color and is often used in jewelry. Ancient Eqyptians also used powdered form of this mineral as eye shadow. Which mineral is this?

a) Sodalite
b) Quartz
c) Lapis lazuli
d) Calcite

14. Amethyst is a semi precious mineral and it is an old Greek belief that it protected its owner from drunkenness and intoxication. The presence of which mineral give it its purple colour?

a) Silicon
b) Titanium
c) Manganese
d) Garnet

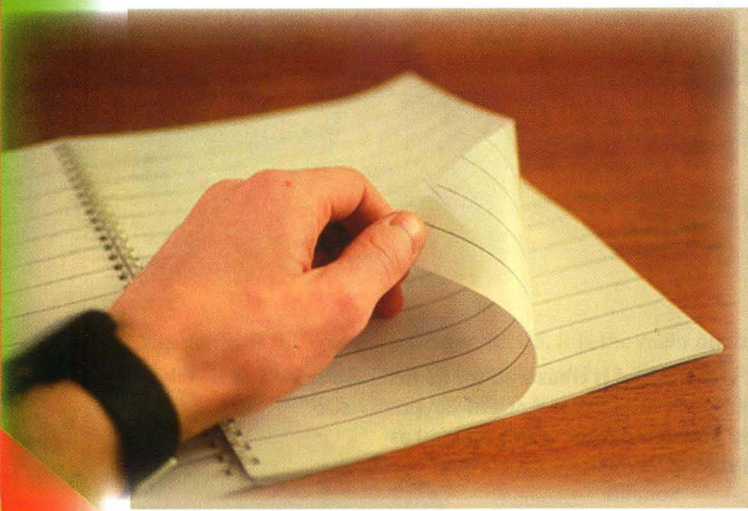
15. As crust it is known as SIAL mainly because it's composition is silica and alumina. The highest ratio of Si: Al is found in which rock of the following?

a) Albite
b) Anorthite
c) Orthoclase
d) Biotite

Answers

1. (c), 2. (c), 3. (d), 4. (c), 5. (d), 6. (a), 7. (b), 8. (d), 9. (c), 10. (a), 11. (b), 12. (b), 13. (c), 14. (c), 15. (b)

Contributed by Ms Preeti Kumari, Research Intern, Wealth of India Division (Geology), CSIR-NISCAIR; Email: preetigeo.pandit@gmail.com

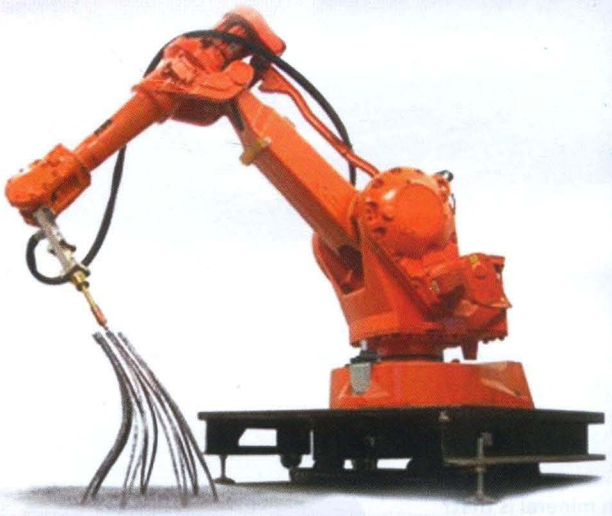


REUSABLE NEVER-ENDING NOTEBOOK

Using a whiteboard has become a familiar activity for creative or academic types. Similarly, carrying around a notebook to jot down notes and sketches is a time-honored tradition. A group of brilliant Canadian inventors figured out a way to combine the two into something that they call Writerase. The Writerase line of products take the best parts of whiteboards and notebooks and smoosh them together. Writerase are easily used and re-used, that's what makes these notebooks so awesome: they don't require you to buy a new one and use up more natural resources every time you run out of space.

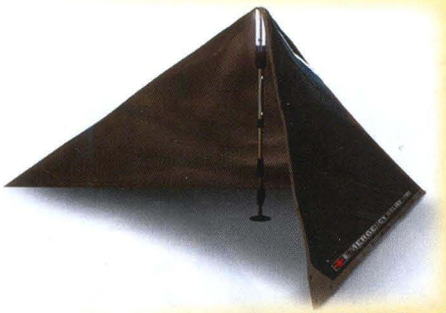
HAND-HELD SCANNER

People with food allergies or intolerances need to be extremely careful about what they eat. The TellSpec Scanner is a hand-held gadget that will analyze the food before people eat it or decide to buy it. It works using a low-power laser and a spectrometer which analyze the contents of a food item, even if it is in plastic or behind glass. After scanning the food, the TellSpec app sends the information to TellSpec's cloud server. The results will let you know the calorie content of the food and whether it contains preservatives, possible allergens, and trans fats, among other ingredients. It will even tell you your nutritional goals for the day and whether you are meeting them.



ROBOT 3D PRINTER CAN BUILD SELF-SUPPORTING METAL STRUCTURES

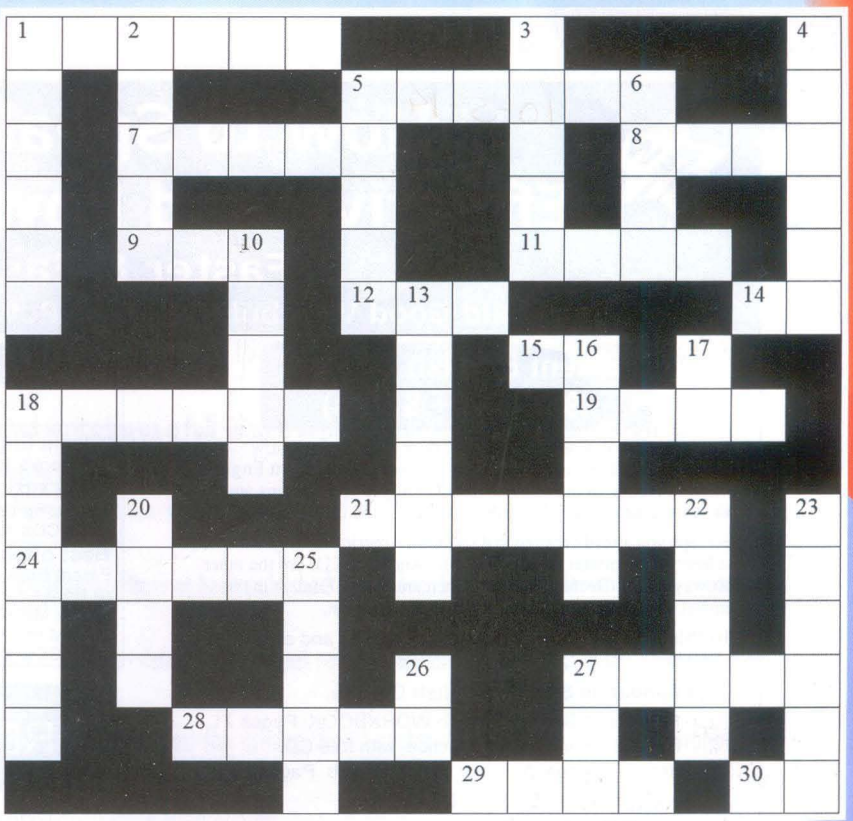
3D printing is taking over the world, now a freestanding robot can print incredible self-supporting metal structures with a combination of 3D printing and welding. The MX3D looks a lot like an automobile assembly-line robot. It works by printing very small pieces of molten metal one piece at a time, slowly building up lines of metal that can stand up on their own in mid-air. The machine can print with aluminium, copper, steel, stainless steel, and bronze, allowing for a variety of effects. What the machine does looks more like art than building.



SOLAR POWERED TENT

From the Sahara to Everest, man has struggled to conquer massive geographical structures. While some complete their trek, others tragically perish, often due to unpreparedness to the harsh environs. The V Plus could become standard equipment for the modern adventurer. The V Plus is a disaster relief tent for those unfortunate souls marooned in disaster relief zones. Its features are plentiful and impressive. Solar cells provide energy; LED lights embedded in the tent's frame provide light. One of the more impressive features is that each individual V Plus can be connected to accommodate multiple people, possibly saving entire teams in the process.

CROSSWORD



ACROSS

1. The time required by the Sun to complete one complete revolution around the centre of the Milky Way galaxy is one ..... year or one cosmological year (6)
5. In a ..... star system there are two stars orbiting around their common centre of gravity (6)
7. The Milky Way, Andromeda and other galaxies are part of the ..... Group of Galaxies or LGG (5)
8. A Black Hole acts like a gravitational .... and bends the light towards it (4)
9. The ... shift in the spectral lines of a galaxy or a star indicates that it is moving away from the observer (3)
11. The Sun is located in one of the spiral .... of our Galaxy and is about 27,000 light years away from the centre (4)
12. One ... is equal to 1000 parsecs or 3260 light years (3)
14. For initiation of the (. , .) Cycle or Bethe Cycle higher stellar temperature than the (P, P) Cycle is required (1, 1)
15. The Henry Draper or .... Catalogue gives the approximate positions, magnitudes and spectral types of a large number of stars (2)
18. The ..... Luminosity Relation provides a cosmic distance scale (6)
19. It has been proposed that an object entering the 'mouth' of a..... hole can emerge from the 'throat' (4)
21. A ..... star has a high speed of rotation with a period as short as a millisecond (7)
24. The ..... structure of the Galaxy has also been corroborated by radio telescopes (6)
27. The ..... stars have a specific position in the Hertzsprung-Russel Diagram (5)
28. Last observable stage for low and medium mass stars
29. The .... Luminosity Relation was proposed by A.S. Eddington (4)
30. Heavier elements beyond ..... are produced in certain stars called supernovae (2)

DOWN

1. The Magellanic ..... are two irregular galaxies situated in the vicinity of the south celestial pole (6)
2. The ..... wind is a continuous radial flow of plasma from the sun (5)
3. A US satellite OSO-3 detected ..... rays emanating from the central regions of the Galaxy (5)
4. The energy produced in the sun and a number of stars is due to the ..... process (6)
5. Even light cannot escape from a ..... hole (5)
6. The concentration of matter and energy prior to the Big Bang is referred to as 'Cosmic Egg' or .... (4)
10. Algol, an eclipsing binary, is also known as the '..... Star' (5)
13. Neutron stars emit radio ..... with remarkable regularity (6)
16. A black ..... emits no EM radiations (5)
17. The ... Hertzsprung Russel Diagram is a plot of intrinsic luminosity (absolute magnitude) and surface temperature (colour) of stars (1, 1)
18. These radio sources have pulses of a second or less (6)
20. The solar .... is a steady stream of particles coming from the Sun (4)
22. The Milky Way in Sagittarius contains stars, globular clusters, ... , bright and dark nebulae, etc. (5)
23. The ..... of the Galaxy is situated in the direction of Sagittarius at galactic longitude of 327º (6)
25. An object will not fall in a black hole if it is outside the Stationary ..... or Schwarzchild radius (5)
26. Hydrogen is converted into ..... in stellar interiors (2)
27. The interstellar matter contains ..... and dust (3)

Contributed by Dr S.K. Gurtu, 80/158, Mansarovar, Jaipur-20

Solution April 2014 Crossword